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Quarterly

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of the

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Vancouver Sun

A 400-ft. long pier and overhead grain gallery, a grain elevator, seed mill, nine freight cars and a car loading shed at the shore end of the pier were destroyed by fire at Vancouver, B. C., July 22. As so often happens when no automatic protection or watchman service is provided, the fire had made great headway before discovery and all structures were fully involved when apparatus arrived. Flames had started through the 1000-ft. long covered conveyor extending across railroad tracks, but were halted just before entering seven grain elevators.

The Quarterly

Vol. 44 October, 1950 No. 2

Fire Preparedness

What should we do to prepare for fire in any possible war? Are our cities likely to be subject to incendiary bombing? What can we reasonably do to prepare for any eventuality? What about atomic bombs? How should we organize our employees for air raid protection? What sort of vault should we have to protect our records against A-bombs? How can we protect our manufacturing plants, our office buildings, our schools, our stores? How should our city organize for civil defense? Do we need greatly increased fire departments, fire guards or other organizations? Should cities be evacuated in case of air attack? What about water supplies for fire fighting, fire alarm and other communication facilities?

These and many similar questions are being asked on every hand. No complete or fully satisfactory answers are available. The difficulty lies not in any lack of technical knowledge, but is due rather to uncertainty as to what kind of attack, if any, may occur, and to what extent we may be justified in diverting energies and resources to possible defensive measures.

Certain principles of fire defense are clearly established as a result of experience in World War II, and some observations can be made which may help the individual in making decisions as to his own course of action. Much has been previously published on the general subject, but the public, lacking complete information is still seriously confused. We are apprehensive, but not to the extent that as a country we are ready to examine all the facts, face reality and act accordingly. Most people support the idea of civil defense, but not to the extent of being willing to inconvenience themselves to any great extent, or to incur any major expense for this purpose.

The experience in World War II was that the greatest destruction for a given weight of bombs was by fire, rather than by explosion, assuming a target favorable to fire. A combination of fire and explosion produced the most effective destruction. We had no experience in World War II with poison gas or biological warfare, and it is beyond the scope of this article to discuss such diabolical agents of death, except to remark that some of the defense measures against fire and explosion may also have some application to defense against these other forms of warfare, particularly the factor of dispersion.

The A-bomb, while a new and fearful weapon, caused essentially the same kind of destruction in the two Japanese cities where it was used as had been inflicted on other cities by a combination of high ex-

plosive and incendiary bombs. From a military and defense point of view the essential difference between the A-bomb and other bombs previously used is a matter of efficiency. A single plane carrying an A-bomb can cause as much damage and kill as many people as a thousand or perhaps several thousand planes carrying ordinary explosive and incendiary bombs. Indications are that the H-bomb, when and if developed, will further multiply the destructive potential of a single weapon, but will not necessarily modify the essential character of the destruction.

It stands to reason that any enemy will try to use its available weapons in the most effective manner, and that in the case of attack by air the targets selected will be those of the greatest density of population, the greatest congestion of buildings, and the greatest fire potential. Valuable weapons will not be wasted on sparsely built areas where the destructive potential of the weapon would be harmlessly dissipated in open spaces.

As we look back on World War II we see that much valuable effort was wasted in civilian defense measures, some of which could not have been effective even if air attacks had occurred. We should realize that our facilities are not unlimited, and should concentrate our efforts in channels where they are likely to be most effective. We are convinced that intelligent efforts directed towards fire preparedness are most essential, and are not wasted even if attack should never come for they would produce great benefits in peacetime fire safety. The NFPA is attempting to make its contribution by analyzing previous wartime fire experience, applying the results to present and prospective conditions, and making the best information available to our members, government agencies and the general public. Our Committee on Civil Defense is actively studying fire problems and providing valuable advice to Federal, State, Provincial and local governmental agencies. We have a Committee on Radiation which deals with the fire aspects of atomic energy. We are sponsoring meetings for the interchange of information and the organization of fire defense programs, and are continually stressing the fact that the fundamental principles of fire safety established through fire experience in time of peace are equally applicable in time of war, and assume greatly increased importance as a factor in national survival.

We have published from time to time important items of information pertinent to this general subject, and will continue to publish significant articles as new data become available. The series of articles which follow in this issue of the *Quarterly* represent a selection of information currently available which we feel will be of general interest and value; we cannot attempt within the limits of the *Quarterly* to include everything published on civil defense. As a guide to further reading we present the following partial bibliography on civil defense planning.

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USSBS, Civilian Defense Division

The NFPA book "Fire and the Air War" describes in detail the fire attacks on German cities. This view of Hamburg shows how typical apartment or tenement house construction wilted under the fire storm attacks of July 1943. The buildings in the foreground had six stories with interior partition walls of brick. Floor and roof frames, heavier than most U. S. construction in this class of property, were wood which, with the usual contents of dwelling units, furnished combustible materials for the fires.

Fire Aspects Of Civil Defense*

By Horatio Bond

So fast have events moved, that the incendiary attacks on English cities in World War II are almost ancient history. We must draw on the English experience guardedly because the heaviest raid on an English city was of the order of 50 tons of incendiaries and high explosives. During the most of the period of attacks on German cities, only the Royal Air Forces were in a position to be effective. The German cities were destroyed before the U. S. Air Forces were in the European Theatre in force. During this part of the war, however, the Royal Air Forces frequently dropped bomb loads totaling 1,000 tons or more on city targets. Over 7,000 tons were dropped on Hamburg. In the closing days of the war, the Royal Air Forces and the U. S. Air Forces made a much heavier attack on Dresden, an attack as heavy, if not heavier, than the A-bomb attack on Hiroshima. It is necessary to make this comparison of the respective weights of attack later in the war on German cities as otherwise we might assign too much significance to conclusions based on the relatively light attacks on the English cities. Yet we should not ignore the fact that damage occurred to one dwelling in five of those in England.

In England, Germany and Japan, the structural damage was principally fire. In cities of all these countries, fire damage measured 80 per cent of total.

The great loss of life in Germany and Japan was due to the fire raids. The largest was probably in Dresden, but we have no figures. On other cities we have the following: Hamburg 60,000, Wuppertal 3,400, Kassel 8,700, Darmstadt 8,100. In Japan, fire raids killed 83,600 at Tokyo and an average of 1,830 in 93 urban attacks before the A-bomb was dropped. The A-bomb loss of life was about 40,000 at Nagasaki, and 80,000 at Hiroshima. We do not need to pursue these statistics further. They are enough to show that large loss of life can be expected. Whether it is 200,000 from an A-bomb, or 2,000,000 from an H-bomb is relative.

Wartime fires are different in one respect from peacetime fires. Peacetime fires usually start in one building and spread to others. Wartime fires start at practically the same time in all buildings. You cannot run fast enough to get out of the fire area and so you perish.

In England, scattered damage occurred and complete burnouts were limited to a few blocks in any one city. In Germany, the areas of burnout reflected the much heavier attack: Hamburg 9 square miles, Wuppertal 3, Kassel 3, and Darmstadt 1½ square miles. One raid on Tokyo burned out 16 square miles. Other Japanese results were: Nagoya 8 square miles, Kobe 3, Osaka 2 square miles. In 93 urban raids on Japan the burned out area averaged nearly 2 square miles.

A-Bombs and H-Bombs

The buildings in Hiroshima in a circle 2 or 3 miles in diameter were destroyed or severely damaged by the A-bomb blast. The fire damage was mostly inside this area. (There was some spread of fire outside this area because of the combustible wood construction of buildings and a

*Extracts from an article which appeared in the "Bulletin of the Atomic Scientists," August-September, 1950.

with interior partition walls of brick. Floor and roof frames, heavier than those of the usual contents of dwelling units, furnished combustible materials for the fires.

Low level air view of the destruction wrought in Kobe, Japan by USAAF incendiary attacks in 1945 shows that even the masonry-walled buildings in the business districts sustained heavy damages. Wood-joist interior construction burned out. Contents of fire-resistive buildings were also largely destroyed as fires entered unprotected windows.

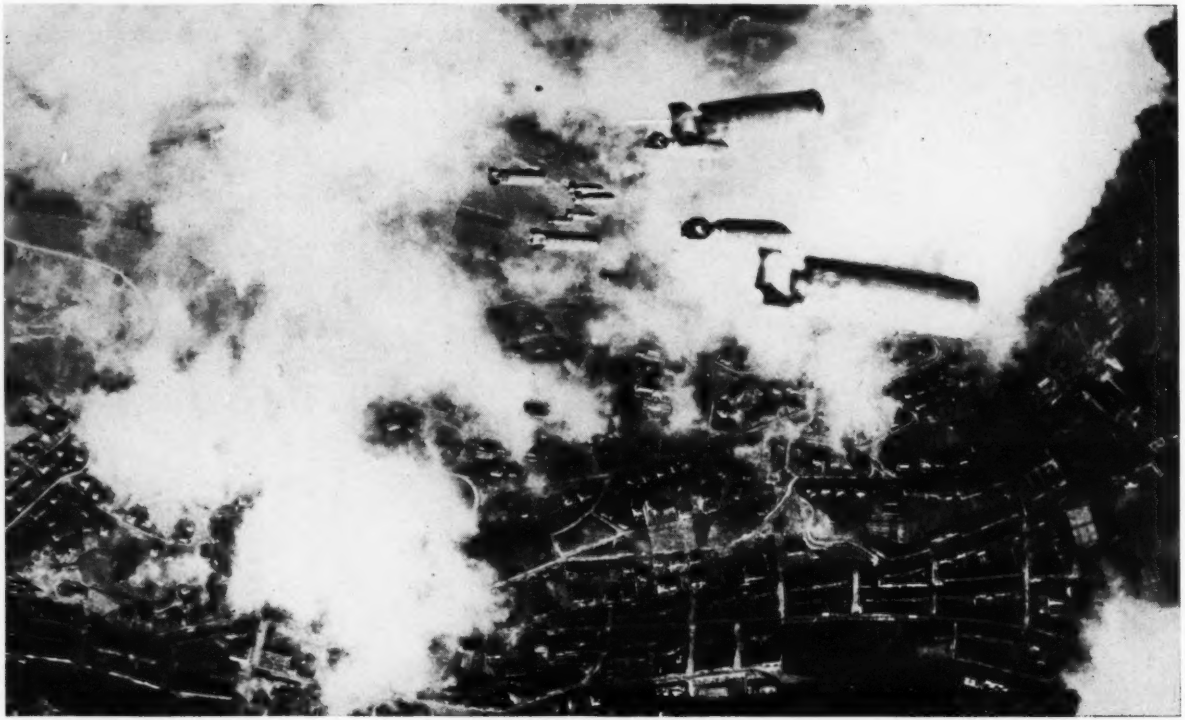
The incendiary attack on Tokyo on March 9, 1945 burned over an area of approximately 15 sq. miles (light areas shown in aerial photograph). The Tokyo Fire Chief, who had thought his Department could control such fires, reported to his Emperor after this raid that he and his force were helpless. Similar large scale attacks on Nagoya, Osaka and Kobe with similar results also convinced USAAF leaders that incendiaries were capable of inflicting decisive damages on Japan.

Low level air view of the destruction wrought in Kobe, Japan by USAAF incendiary attacks in 1945 shows that ... buildings in the business districts sustained heavy damages. Wood-joist interior construction burned out. Contents of fire-resistive buildings were also largely destroyed as fires entered unprotected windows.

fairly high built-up-ness. Thoughtless observers are concluding that similar spread would occur in any city and we must be careful to note that the fire spread was due to the special local conditions. Similar fire spread would not have occurred in a German city where compartmentation by fire walls is the rule.) The burnout at Hiroshima was an area of 4.4 square miles. At Nagasaki (where local conditions were different) the burnout was 1.8 square miles.

When persons start to talk about A-bombs larger than those used at Hiroshima and Nagasaki, or about H-bombs, about all they can do is draw circles of damage which have larger diameters.

We have to plan civil defense measures to deal with a city, the center area of which is gone and with a wide ring of territory outside this center in which the damage is partial. Near the center the damage will be complete and fires will probably destroy what the bomb blast does not. Toward the outer perimeter of this ring, there will be some chance to deal with fires.



Official Photo, USAAF

James K. McElroy's analysis of "Incendiary Warfare on Germany," published in "Fire and the Air War" indicates that "to be successful, incendiary attack must overwhelm the civilian fire-guard by the use of sufficent high explosive or drive him underground for sufficient time to allow an incendiary bomb to initiate fire in contents or structure." This photo shows clusters of incendiary bombs, together with explosives, falling toward the city of Dresden as the USAAF attacked that city on Feb. 14, 1945 following an RAF attack the night before from which fires were still burning.

It is apparently possible to design a bomb of any size. There is no sense in making a bomb too big — it doesn't need to be any bigger than necessary to take out a target city. If an H-bomb can be built with a 40-mile diameter of destruction almost any existing city of 300,000 population can be destroyed by one bomb. The bomb is big enough to destroy many cities where a larger population is crowded into a 40-mile circle.

Action in Fire Defense

It is important that we know what kind of situations we are likely to be up against in order to effectively plan for civil defense. The foregoing recital of the principal facts about the fires of World War II enables us to narrow down a bit the field of possible action. Possible action may be discussed under four subject headings: (1) measures to reduce vulnerability of city and industrial targets discussed in the article on page 92, (2) arrangements for water supply for fire fighting, (3) first aid fire fighting (the fire guards) and (4) fire fighting by public fire departments. Most of the other problems of civil fire defense are collateral to one or another of these subjects and so through these four items we can have a pretty good look at the whole problem.

Water for Fire Fighting

A lesson of the bombings of World War II is that if you expect to fight fires which are caused by bombs, you must have a water supply in which the water for fire fighting is stored near the building on fire. Water supplies from conventionally designed public water systems are interrupted by the bombs which fall. As a principle, therefore, we cannot rely on any system in which water is piped long distances. At Hiroshima, the public water supply was made useless by the large number of broken service connections, flow from which depleted the supply.

This is a matter to which almost no thought has been given and to which the operators of the public water utilities seem to have a blind spot. There has been hardly any discussion of the subject among water works people. It is high time we did a little realistic thinking about it.

Most people assume that we will be able to do something, as they did in England and Germany and to some extent in Japan, and provide static water sources by means of tanks in streets, reservoirs in cellar holes and access points at streams and ponds for pumper suction. There is no real appreciation of the difficulties of a practical and technical nature in building and maintaining these alternate water sources. Such measures as were undertaken in World War II were in the nature of makeshifts and the individual schemes have had no thorough study by persons on this side of the water. The first step therefore is a study and appraisal of these wartime measures.

As a principle, water supplies must be provided in which all of the water needed for fire fighting is stored near the property for the protection of which it is provided. This principle is often followed in the protection of industries so it isn't as radical as it may sound. A wartime water supply for industrial fire protection would be something as follows. There would be a gravity tank with a generous supply of water to supply sprinklers or hose streams in the early minutes of fire fighting. A large storage tank would be a secondary supply, providing water for fighting a fire of several hours duration. Sprinklers would be very desirable, as they conserve the use of water. If the plant is blown down by bomb blast the plant is destroyed anyway. If, however, the plant is in an area of partial damage the sprinklers are

...allow an incendiary bomb to initiate fire in contents or structure." This photo shows clusters of incendiary bombs, together with explosives, falling toward the city of Dresden as the USAAF attacked that city on Feb. 14, 1945 following an RAF attack the night before from which fires were still burning.

USSBS, Civilian Defense Division

The vicious fire attacks on Hamburg, Germany in July 1943 caused damages such as illustrated here. On July 27 and 28, incendiaries set fires over an area of 17 sq. miles and street frontages involved in this great fire area totaled 133 miles. The construction of buildings in this section of Hamburg would be considered superior from a peacetime fire protection viewpoint, but so many fires were started simultaneously that no fire department would have been capable of coping with the conflagrations produced by these fire storms.

likely to be still in service. If the gravity tank is blown down, the ground storage of water may be intact, especially if an underground reservoir or a pond is the source of storage provided. To guard against power failures, at least one fire pump, gasoline engine driven, could be provided which would assure the availability of the water for fire purposes.

Note that all these measures are simply adaptations of proven methods of peacetime fire protection and desirable in peacetime as in wartime. One possibility is that the mercantile districts of cities should be protected by water systems like these industrial layouts described. By having a separate system for each block, or for each of a group of blocks, features of unreliability of conventional systems would be overcome.

By providing such local storage, peacetime fire protection of a superior order could be achieved so that the measures would not be wholly an economic waste like most features of wartime preparedness. For first aid fire fighting, the large local reserves of water would be supplemented by numerous smaller tanks from which buckets and pump tank extinguishers could be refilled.

Fire Guards

In dealing with wartime fires, first aid fire fighters, the fire guards, were important. In England, for example, many buildings were saved by resolute fire guard teams with stirrup pumps and buckets, and occasionally small hose stream equipment. Since with any large bomb, there is likely to be a large area of partial destruction in which fires will occur, it will be worth while for every property to have its fire guards. The value of these teams is that they are likely to be right on the job when the bomb hits.

In England, the fire guard service was the largest civil defense agency in point of numbers of people. They were principally organized for night duty because the incendiary attacks usually came at night. The fire guards eventually became a permanent force, with team members paid for the hours of service. Also, the fire guard service was completely independent of the regular public fire services. I think this latter principle would apply to any fire guard scheme of another war, because the fire guards are a group of different people than the regular firemen, and the teams were not designed to be mobile in the sense that a fire company is mobile. I do not think we have evidence yet to determine whether all fire guards should be expected to serve round-the-clock and whether it will be necessary to organize them into a formal service. There will be some important properties where round-the-clock first aid fire fighting service will be appropriate.

This is a field in which we can make an effective start in peacetime. There is no wasted effort in increasing the number of people who know how to use a fire extinguisher or a pump tank.

In wartime fires in a bombed city there will never be enough public fire-fighting companies available. In general, the public fire departments will have to make a selection of the fires which they will try to reach and attack. Because they can reach only a fraction of the fires, the principal fire fighting will necessarily have to be done by the fire guards.

Public Fire Departments

Public fire departments are emergency organizations and, whatever the emergency presented, will give a good account of themselves. However, in assigning a decisive role to public fire departments

over an area of 17 sq. miles and [illegible] from a peacetime fire protection viewpoint, but so many fires were started simultaneously of Hamburg would be considered superior department would have been capable of coping with the conflagrations produced by these fire storms.

in civil fire defense, we would be making an important error. Fire departments are simply not a wartime fire-fighting organization. They are set up in the expectation that they will have to deal with only a few fires at a time. At Hamburg, a pre-A-bomb fire was burning on street fronts totaling 133 miles. The Hamburg Fire Department was one of the best in the world. The resultant destruction would have been little different if it had not existed. Mobile fire-fighting units provided by the government were available to aid the local fire forces at Hamburg. Even what seemed to be a huge mobilization of fire forces, did not appreciably affect the result. With the greatly increased potentialities of destruction in modern bombs, the idea of mobile fire forces to augment the existing forces in any city is simply a totalitarian dream. One of the surest ways to lose a war would be to tie up manpower in such an essentially useless force.

We have got to reconcile ourselves to a large area of destruction in any location bombed. Our efforts should be directed to preventing needless loss of essential services, and the public fire service should not be used up in dealing with hopeless fire situations. It makes sense to put municipal fire stations in the fringe areas of the city rather than the center. It is desirable to give fire departments good communication facilities so that they can disperse their forces to locations where they can do some good. We should examine the organization, training and equipment of fire departments to make sure they are effective organizations.

Organizational Problems of Fire Departments

Anything which may be said at this point about fire departments would be in the nature of a digression from the main subject of civil defense, but it may be useful to discuss some fire department organization problems. Wartime experience did throw considerable light on them.

The English experimented with fire department organization and learned some valuable lessons. Before the war they had some 1,400 fire departments in England and Wales. Most of these were small units. Even in Canada and the United States there are 15 one-company fire departments for every large paid fire department. Facing wartime fires, the English concluded that most fire departments were too small. They tried integrating them loosely in a system of mutual aid which was virtually the same sort of arrangements which fire departments on this side of the water adopted. When the crisis came, these loose integrations did not work. The small departments were under local municipal control and the local control governed when what was needed was an arrangement where fire companies could be moved in a metropolitan area or region without recognition of the limitation of municipal boundaries.

It is generally not recognized that by the time the British National Fire Service was actually set up, the Royal Air Forces had won the battle of Britain. The National Fire Service was never tested by attacks heavy enough to give it a real workout. However, in building that service, some principles of fire department organization were developed. Any fire department organization can be examined in the light by these principles.

Certain principles are obvious: there must be adequate numbers of men, appropriate and sufficient equipment, a system of training. With respect to these, our fire departments in the United States and

Canada would appear good. A principle also, is that the firemen must be a homogeneous force, all working under the same conditions of service. Another is that there should be a clear line of command with a single system of officer ranks universally recognizable. Another is that plans for the movement of fire companies must be such that they can be held to. Still another is that exercises be held so that fire companies can be readily moved from one district to another. These four principles are usually met in large city departments so far as operations within the city are concerned. They are not usually met when a number of departments are working at a fire in a neighboring city, as under a mutual aid arrangement.

There are two other principles. There must be officers in sufficient numbers with the proper technical experience and skill, and fire force units must be efficient for purposes of administration and operation.

While the English experimentation with organization clearly showed up the advantages of larger fire departments, it is demonstrated also that a fire department may reach a size at which it is too large. The National Fire Service was simply too big, and I gather there were few tears shed at the decision, after the war, to return the fire departments to local authority control. But it is important to note that the local authorities to which the departments were returned were 140 in number instead of the pre-war 1,400. Each of the fire departments postwar is large enough to be reasonably efficient; each can afford a headquarters technical staff for fire prevention work, training and other functions, and yet offers real careers to members.

There are a number of interesting setups elsewhere around the world in which large fire departments are obtained while retaining the advantages of small or volunteer fire companies for outlying suburban and rural areas. The arrangements in Quebec, which have been in force for many years, are aimed at that objective as are the provisions of Ontario's recent fire department legislation. The most logical development of this principle is in the statewide fire departments in New South Wales and other Australian states. We have examples of the same sort of thing in two large county fire departments in the United States, in Los Angeles County, California, and Nassau County, New York. In the past year, the fire services of New Zealand have been consolidated into a single department. While the immediate cause of New Zealand's action was the fatal department store fire at Christchurch,* the move had been under study for years.

In other places, the problem has been recognized, and the possibility again of fire department operations under a wartime situation, may suggest additional provincial, state or regional plans for integrating small fire departments into more effective and larger organizations.

In conclusion, it appears that we should approach the fire problems of civil defense in the following order of their relative importance.

1. Measures of city planning to reduce vulnerability.
2. Water supplies for fire fighting.
3. First aid fire-fighting arrangements through organization of fire guards.
4. Fire department organization.

*See Jan. 1948 *Quarterly*, **Frontispiece.**

American Strategy On Civil Defense

By Dr. R. E. Lapp

The rapid cascade of recent events looms as the overture to war. As a result civil defense has become a matter of life-and-death seriousness. What is to be our strategy in the defense of our sprawling cities with their congested masses of population? How do we face the peril of an atomic war?

Before we launch into a discussion of what we can do in the area of civil defense, we should consider what has been done and what is being done. Just where do we stand on the vital issue of civil defense? The past can be summarized very briefly by saying that we have toyed with the problem by writing a few reports on civil defense administration. Nothing of any substance has been accomplished in the past five years.

A few cities have made preliminary skirmishes with the civil defense nightmare. Washington, D. C., in particular, has publicized its attack upon the problem. Last week it was announced that $200,000 had been appropriated for the newly created Office of Civil Defense for the District. Almost simultaneously $15,000,000 were approved for the construction of another government building in the heart of the nation's capital. Thus we proceed, one step forward and ten steps backward.

We will begin to be serious about the protection of our cities when we stop cramming more buildings into them. The city is the heart of our vulnerability to atomic attack. Unless we reduce the concentration of buildings and people in them we will never know true civil defense.

Today there is great interest in civil defense but there are no civil defense measures in effect which will be useful in time of attack. The cities look to the Federal Government to supply the plans for home defense. Last month a group of civic leaders on the west coast ganged up on the National Security Resources Board and demanded that the Board produce its civil defense plan. Under this pressure, Dr. Paul J. Larsen, Director of Civilian Mobilization for the Board, stated: "...I want to assure you that the Federal Government is developing a modern, flexible, and practical Civil Defense program to meet all types of twentieth century warfare. We have little doubt that the final results, implemented by state and municipal authorities and the general public, will

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Dr. R. E. Lapp is a well-known American physicist and co-author with Dr. H. L. Andrews of the standard technical book "Nuclear Radiation Physics." Dr. Lapp is especially familiar with the military aspects of the atomic bomb. He was a member of the Manhattan Project and has served a number of military agencies as a scientific adviser being, for example, at both of the Bikini experiments. He was Executive Director of the Committee on Atomic Energy of the Research and Development Board of the U. S. National Military Establishment. His interest in the problems of cities is explained in his book "Must We Hide?" which deals with the effects of atomic bomb attacks. He is now in private consulting work at 1745 Euclid St., N.W., Washington, D. C.—Ed.

This article is based on a paper delivered at the American Conference on Foreign Affairs at Colgate University, Hamilton, N. Y., July 8, 1950.

be adequate to whatever situation an enemy might impose upon us."

The N.S.R.B. plan is due out in September.* It is highly probable that this plan will be a new edition of the Hopley Report, revised and enlarged, and with something for everyone in it. I suspect that it will be a very detailed treatise listing what the police, firemen, mailmen, and doctors should do. By its very bulk it will show that official Washington is hard at work on civil defense. It will satisfy the politicians and the non-critical civic leaders for there will be a wealth of fairly inexpensive and not too annoying projects which the cities can undertake.

There is, however, no civil defense program either in fact or in preparation which can be both pleasant politically and yet adequate to cope with atomic attack. The only effective atomic defense consists in dispersing our industry and our population. It involves before-the-fact measures not after-the-fact relief. But dispersion is political dynamite. Can you imagine Senator McMahon voting to move defense industries out of his state or even transferring them within Connecticut?

While dispersion is the only really effective answer to the atomic bomb and to the hydrogen bomb, as well, it is a defense which requires years to perfect. The acceleration of world events focuses attention upon the more immediate future. Civic leaders want defense now not in 1960 or 1970.

The city fathers also want a defense which will not be very expensive and will not upset the *status quo* of community life. Any plan, such as dispersion, which would upset the established pattern of city life, will be disregarded.

No such magic plan for civil defense exists. Nor will any be found this summer. The hard facts of the situation are that you cannot live in a large city and still be safe from atomic attack. Improved A-bombs and the yet-to-be-developed H-bombs are powerful weapons that can blot out areas 10, 25, or 50 square miles at a single blow. Thus an attack can wipe out a small city and eviscerate even a large city with the employment of a single bomb.

You cannot provide effective defense if you wait for the attack to occur and then rush around after-the-fact trying to reduce the casualties. Yet this is precisely the philosophy of the few people who have emerged from Washington to advise local authorities on civil defense planning. Great emphasis is placed upon the training of medical men so that they will recognize atomic injuries and know how to treat them. Now we must certainly make provision for such palliative measures but it is ridiculous to base a civil defense plan on such an approach.

Consider, for example, a single atomic attack upon Chicago. Using an atomic bomb an enemy could kill 200,000 and injure 250,000 people. Imagine treating and hospitalizing a quarter of a million people in one day in a single city! The blood plasma requirements alone are out of this world. It would take a year's blood plasma supply for the whole United States to handle this single catastrophe.

An atomic bomb is a triple-threat weapon for it combines three effects into a single package. When a bomb is exploded damage is done by the blast effect

*This plan is now available from the Government Printing Office, Washington 25, D. C., under the title "United States Civil Defense," 25 cents per copy.

which knocks down buildings and destroys facilities over a large area. There is not much you can do about the blast effect. You may wish to build stronger buildings but to make a bomb-proof building is impractical.

The fire hazard accompanying an atomic detonation is extremely serious. Even if you increase the size of your Fire Department to ten times its present size it will not have much effect on fire damage. To be truly effective before-the-fact measures must be undertaken. Such projects as green belts or fire lanes through a city will be most effective in confining the myriad fires which break out simultaneously after a bomb explosion.

The third hazard from the superexplosives is radioactivity. When a bomb is exploded there is a flash of penetrating radiation which does damage to human beings within one mile from the explosion center. If the bomb is burst in air then this is the only hazard from such an explosion. If the bomb is burst at the surface or below the surface, as in a harbor, bomb fragments are trapped and remain in the vicinity where they may constitute a radioactive hazard.

Radioactivity has become a kind of a national villain. As such radioactivity has been grossly exaggerated as a hazard and I personally believe that in an atomic war we would pay little attention to it.

The best way to avoid being injured by an atomic explosion is to be as far away as possible when the bomb is detonated. This self-evident fact should form the real basis for civil defense.

This ideal solution of "not being there when it happens" has two aspects. On a long time base we can arrange our industry and our population so that they do not concentrate into a few prime target areas. This is true dispersion. It is the only civil defense measure which provides security during atomic attack. On a short time base we can simulate dispersion by evacuating our cities.

Once war seems inevitable and attack is imminent, evacuation of our large cities must proceed on an orderly and a planned basis. Millions of people must be moved to villages, towns, and hamlets, or to houses by the side of the road. Our metropolitan areas will become temporary ghost towns inhabited only by skeleton crews of essential workers necessary to keep the city in stand-by condition. The industries which we have been so foolish as to leave in the metropolitan zone will have to be staffed by workers who will live in outlying communities. Such evacuation is the only means of preventing millions of casualties which would otherwise result if the cities were inhabited.

The drastic relocation of millions of people in the space of a few days calls for the utmost in planning transportation, housing, food supply, and communications. Yet if we do not plan we may witness a terrible Orson Welles-like exodus from our major cities. Rather than risk the catastrophe of a headlong outgushing of massed humanity from our cities, we should plan for the orderly redistribution of these people to areas which are safe from the threat of attack.

Some may argue that people will stay put in cities and take their chances of being obliterated. This may be true before the first A-bomb is exploded, but I think that the first detonation will induce an exodus from most cities. There is a very great difference between taking chances with ordinary bombs and with an A-bomb. You

can always hope that a block buster will fall two blocks away. Furthermore not all the blockbusters are dropped at the same instant and you can seek shelter. With the case of the A-bomb the attack is virtually instantaneous and even if it explodes a mile away your chances of survival are not good. I think that this difference is enough to convince people that it will be healthier to sleep in a hay stack ten miles from the city limits rather than in a feather bed in the heart of the city.*

The rate at which we prepare for civil defense is the subject of much controversy. Some argue that the Russians cannot possibly have more than one dozen A-bombs now and they cannot produce more than two dozen a year. I think that it is wise, especially in view of our recent underestimation of Soviet capability, to assume that these figures are lower limits. I think that it is more reasonable to assume that the Red bomb stockpile will top the 100 mark by 1952 and to lay our plans accordingly. Others argue that if we put too much emphasis upon civil defense now and no emergency occurs very soon then people will lose interest in it and we will thus prejudice the success of effective defense at a later date.

Whatever your viewpoint or your estimate of Soviet capability I think that it is high time that we did something about our civil defense muddle. But we must not proceed in a harum-scarum fashion. There is still time to analyze each proposed civil defense measure, to assess its effectiveness, and to plan for implementing it. In doing so there will always be a number of factors which will elude us. For example, one of the most critical factors in the defense of our cities is the detection of an enemy attack and the alerting of the populace.

If we get a 1-day alert we can proceed with large scale evacuation of the populace from the large cities. If the alert is only 1 or 2 hours then all we can do is to have everyone seek shelter as best they can. Should there be no alert the casualties will be a maximum. With a 1-day alert casualties can be reduced to a few per cent. A 1-hour alert may still allow the casualties to be reduced by a factor of 2 or by as much as 10 under the most favorable circumstances.

No one can predict how much if any alert time will be given. Under this circumstance it seems reasonable to play it safe by evacuating our cities prior to an attack even though this may mean some false alarms.* Certainly, there should be some foreboding of an attack in the form of mounting international tension.

One reason why it is so difficult to predict the extent of an alert is that Russia can attack continental U.S.A. in a number of different ways. Too often defense planners have thought only of bomb delivery via the aerial route. This is, perhaps, a result of translating our own offensive position to that of the enemy. Many Soviet targets are deeply imbedded within the Eurasian land mass, well away from coastal approaches, and tightly secured by an Iron Curtain. On the other hand, the United States has thousands of miles of shoreline; furthermore, it has no Iron Curtain. Our overstuffed American cities are accessible to attack by air, by sea, or by stealth.

A radar picket fence or an aircraft spotting system may be only partially effective in detecting an aerial attack and it will be

* For additional ideas on evacuation, see article on "Escape from Cities," starting on page 98 of this *Quarterly*.

completely ineffective against the other means of delivery. If we consider only the aerial route, the Russians, according to Mr. Symington " . . . are capable of delivering a surprise atomic attack against any part of the United States." Furthermore, the Chairman of the National Security Resources Board, added, "Today, the United States has no adequate defense against such attack."

During the next few years our military defenses may be bolstered; we will probably get more interceptors, more radar, and even a number of skysweeper guns for city defense. Interceptory guided missiles may make their appearance in about 5 years. But only an extreme optimist would say that the invading bombers can be intercepted successfully. When one considers a V-2 type missile launched from a submarine lurking a hundred miles off our coast, the possibility of military defense seems more remote.

Thus it would seem that Russia will soon have the capability of launching serious atomic attacks against continental U.S.A. We, who have always in the past enjoyed territorial isolation, are now faced with the vicious threat of the A-bomb. Not knowing whether an attack will come next year or in ten years we must prepare to live on the edge of peril. The prospect of living under the shadow of the bomb is a dread one yet we must determine to prepare for the worst.

No one knows whether it is part of the Soviet war plan to bombard American cities with A-bombs. Fear of retaliation in kind might be expected to deter the Soviets through "mutual terror," as Winston Churchill put it, but there is not real assurance that it will. Should we ever relax our defense effort and allow our retaliatory forces to deteriorate then we might suddenly find ourselves on the receiving end of a vicious attack. Or we might be lulled into complacency by a false peace and be rudely awakened by an atomic blitzkrieg. We must assume for purposes of planning that our cities will be attacked in a future war. In addition, it would be folly to assume that A-bombs will not be used in such a war.

Now that we live in the uneasy days of the overture to war, we must set about educating our people to the real hazards of modern warfare. The real hazards are something less than the wild tales of emotional scientists and sensation-seeking writers. We must put an end to these exaggerations and replace them with facts. This can be done by the National Security Resources Board if it will have the courage to prepare a straight-from-the-shoulder appraisal of the hazards of modern warfare. It will take real courage for in Washington they are continually conducting OPERATION PUSSYFOOT. They take the attitude that if you tell the average man the facts he will either not understand them or will be panic-stricken. They say that the facts are secret and cannot be told.

Now that the Russians have the A-bomb secrecy is a mighty thin excuse for stalling on civil defense. The argument that Americans will be scared stiff by the facts is palpably absurd for they have already been exposed to far more hair-raising stories. The real facts will be somewhat of a relief. To withhold the facts because public officials feel that Americans can not understand them is an affront to our democratic tradition. For only if we trust

the American people and give them this problem will we ever arrive at a solution. Civil defense cannot be master-minded in Washington. The real problems are concentrated in our teeming cities and it is here that the solutions must be found by the civic leaders and by the man in the street.

The atomic threat to American security poses a multitude of new problems for us. Each problem must be analyzed objectively and viewed in relation to the whole complex of civil defense. To date we have not done this, instead we have gone off willy-nilly on training doctors for radiological defense and talked about Geiger counters as the answer to our problems. Unless we view each undertaking in proper perspective we will continue to go off half-cocked on weird approaches that will do little but waste time and money.

Effective civil defense will not be a pleasant tea party or a congenial group of civic committees. Realistic defense measures will make inroads upon our established way of life. It will require personal and civic sacrifice. In the long run civil defense will alter the profile of city structure, it will completely reorient the scheme of real estate values, and it will spell the end of the metropolis as we know it today. I believe that before this century ends we will see new types of communities, sleek ribbon-like strip cities no more than a mile wide yet stretching clear across a state. The sprawling metropolis with its tight cluster of sky-piercing buildings will be obsolete for the simple reason that it was too vulnerable to atomic bombs. How we proceed to transform our cities will depend upon our vision and courage. I hope that it will not depend upon our learning a tragic lesson in the broken stubs of our once proud cities.

In summary, our civil defense headache centers in our large cities. To provide truly effective civil defense we must undertake before-the-fact preventive measures, such as dispersion over a long time base and evacuation in time of a threatened attack. Our basic strategy must be to have done our job before the bomb drops. Any civil defense plan which is based upon after-the-fact relief measures is doomed to failure. The magnitude of an atomic attack is potentially so great that it will overwhelm us if we wait until the bomb drops to go into action. There is no magic defense plan which will allow you to stay in a city and still be safe.

We may have to live in an atmosphere of international tension for years or even decades. As the years go by the weapons of mass destruction will become more plentiful and more destructive. The H-bomb will make its debut. In such a world we must be serious about civil defense for it will constitute our national life insurance.

Escape From Cities

"Possibility of Atomic Attack Speeds Suburban Movement — reads a recent headline in a Milwaukee newspaper. The story reported a study made by a nation-wide real estate organization on the impact of the atomic era on real estate purchases.

"The census of the Milwaukee metropolitan area confirms the current trend of flight from the central city. Although the impelling force in this flight is more than just the fear of an atomic explosion, nevertheless, the thought of abandoning the main city and of fleeing to suburban areas has occurred to nearly every mature person. News stories, such as the one mentioned, continue to spur the movement.

"In some instances the instincts of the average mind are better weather vanes than are the official policies of government. The popular belief concerning the danger of living in cities in the atomic age may be such a weather vane. The prevalent wave to escape the cities formed a principal spur to the formation of a civil defense group in Milwaukee."—Frank P. Zeidler, Mayor of Milwaukee, Wisc., in Bulletin of the Atomic Scientists, August-September, 1950.

It should be clear that with cities and industrial plants as they are, there would be no difficulty in destroying them. They could be destroyed with incendiaries and high explosives even if the A-bomb were not a reality and even if the H-bomb can never be built.

The same general principle applies to all large bombs. The enemy looks at the United States cities of New York and San Francisco and notes that any bomb which he can deliver has an excellent chance of killing a lot of people and destroying a lot of buildings. Manhattan has a daytime population density of some 145,000 per square mile. On the other hand, he looks at Los Angeles and Houston. These cities are not so attractive as targets. They are so spread out that many bombs would be needed to accomplish the same destruction a single bomb might do on Manhattan. An enemy is going to choose his targets and if they are hard to destroy he may decide that they are not worth the effort.

Consequently we have the one very practical defensive measure, the use of space. If we are willing to space out our buildings we can avoid the concentrations of people and buildings which lend themselves to ready destruction.

The National Security Resources Board, which is an agency advisory to the President of the United States, is charged with responsibility for civil defense planning. One of its first publications on the subject was entitled "National Security Factors in Plant Location." This outlined a realistic and practical approach to the problem of industrial dispersion as a defense measure. This brochure offered no radical or hysterical program. It said in effect that concentration of industry in the future must be avoided. It did not suggest that existing plants be uprooted and moved. It did point out that, in the normal course of things, industry would be planning new buildings and new plants. It recom-

mended that whenever a new building was to be built, it be built with a space separation from existing plant structures. When extensive plant enlargements were considered, it asked management to study the possibility of locating the new facilities away from existing congested industrial areas.

The same approach should be applied to our congested cities. No more skyscrapers. No more congested housing projects. If slums are cleared, leave them clear. Build new buildings in such a way as to keep down the concentration of people. By these measures we may get more comfortable cities, not to mention badly needed parking space between buildings. However, any immediate wholesale decentralization of congested cities seems economically impossible. Even if other factors permitted, the loss of real estate values in urban centers might be an almost insuperable obstacle to any really effective measure prior to an enemy attack. After the object lessons of the results of an attack the resistance to decentralization might be reduced, too late.

There is, to be sure, a gradual and natural trend toward decentralization, brought about by natural causes and perhaps accelerated by the fear of war. Industry is building new factories in suburban or rural areas, people are living farther away from large cities and retail shopping centers are springing up in outlying areas. These developments are due to a variety of causes, to tax situations, to urban congestion, to a desire for country living, to the need for better labor conditions, to improved transportation facilities and other causes. This trend, while stemming from wholly different motives, is clearly in the right direction from the point of view of fire defense. But will it go far enough and be completed soon enough to be effective?

A mass movement of people out of a large city in advance of an attack may be possible, but it seems to be an expedient of doubtful value. Evacuation of cities would be possible only when there was advance warning of impending attack, and there is no assurance of adequate advance warning. Furthermore, with a city evacuated it would be highly vulnerable to fire, air-set, by sabotage or accident. Factory production would stop, and with a succession of false alarms the whole effectiveness of the city as a factor in the war effort might be seriously impaired. It would be far better to start now to make our cities less attractive targets.

J. C. McKenna, Jr., Courtesy Providence Journal

Storage of critical materials in a manner in which they would be vulnerable to fire destruction was tragically illustrated during World War II by the loss of thousands of tons of crude rubber in the Firestone Rubber and Latex Products Company plant in Fall River, Mass., October 11 1941. (See Jan. 1942 *Quarterly*.)

Protecting Our Resources

By Robert S. Moulton

Our ability to wage effective war in case we are attacked depends in large measure upon maintenance of our capacity for production and upon adequate supplies of materials. Both productive capacity and material supplies may be subject to serious impairment by fire, and a fire safety program quite similar to that of any good peacetime program is a major part of any effective wartime plan for safeguarding industrial production.

Fire experience in World War II showed that in many cases military and other government authorities did not fully appreciate the importance of fire protection as an essential element in the war effort. While, as the war progressed the subject was approached more intelligently, there were many serious fires which caused an unnecessary drain on our supplies of strategic raw materials and on our production facilities. This wartime fire experience highlighted certain features which should receive more effective attention in case of any future conflict, and which, in fact, should receive *immediate* attention *now* by way of preparation for any future war as well as in the interest of good peacetime practices in fire protection.

Strategic Materials and Production Facilities

While the essential principles are the same, there are certain differences in approach to the fire problem in war which call for some modification of our thinking. The first factor to be considered is that any program of wartime fire protection must be based upon the actual value of the facilities to the war effort rather than upon dollars. During World War II, in a number of cases, important materials were stored under conditions that made them particularly vulnerable to possible destruction by fire. Those in charge felt that they had discharged their responsibilities because the materials were fully insured at a cost to the government which seemed very reasonable. Assuming complete destruction of such supplies, there is no question but that full reimbursement would have been made in dollars, but at the time additional supplies of natural rubber and many other materials simply could not be bought with dollars.

In many industrial plants elaborate precautions were taken against sabotage, but at the same time no apparent thought was given to fire protection. It was not realized that in the average plant the only means of wholesale destruction available to the saboteur was fire. Explosives could not be brought into a manufacturing plant in sufficient quantity to cause complete destruction without being conspicuous, but a single match applied in the right place could destroy an entire plant. Thus, automatic fire detection and extinguishing equipment, organization of plant fire-fighting forces, adequate water supplies for fire extinguishment, subdivision of areas by fire walls and various other elements that are important to the individual plant's general fire safety program all play their part in protection against fire as the major weapon of the saboteur as well as fire of accidental origin.

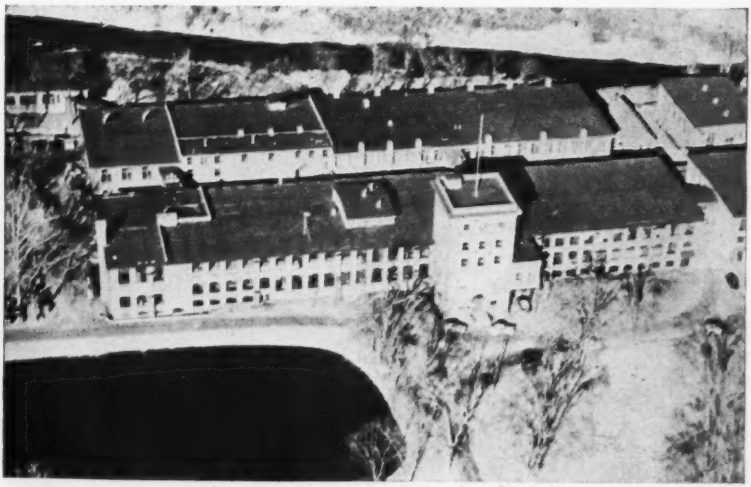
Storage of critical materials in a manner in which they would be vulnerable to destruction by fire was responsible for the loss of thousands of tons of crude rubber in the Firestone Rubber and Latex Products Company plant in Fall River, Mass., October 11 1941. (See Jan. 1942 *Quarterly*.)

Later on during World War II, on Feb. 17, 1943, another stockpile of rubber was destroyed in an unsprinklered 51,200 sq. ft. building in North Kansas City, Mo. Some 10,000 tires are said to have been destroyed. North Kansas City did not learn from Fall River and on March 15, 1950 history again repeated when some 80,000 tires and 70,000 tubes were destroyed by fire in another North Kansas City rubber warehouse. (See April 1950 *Quarterly*.)

International

Diesel engines, electric generators and other valuable equipment made on war contracts were destroyed in this New York warehouse on October 8, 1943. No consideration had been given to dividing the material in the 59,000 sq. ft. structure, about 54 per cent of which was of wood construction.

Insufficient spacing of piles of raw materials was never more forcefully illustrated than in this fire at New Bedford, Mass. on March 25-30, 1943, when 9,000 bales of jute, part of the government stock pile of this critical material, was destroyed. Swelling bales caused roof and wall collapse, narrow aisles allowed fire to flash from one pile to the next, and high piling impaired the effectiveness of sprinkler control. (See. Jan. 1944 *Quarterly*.)



Subdivision of values was not considered in the storage of lend-lease supplies in 1944 by U. S. Treasury Department at this Rockaway, N. J. storage facility. Utilizing an old, structurally weak, former textile plant, an estimated $11,000,000 of shoes, blankets and other supplies were stored in these two warehouses. Fire destroyed one (farther in the photo) after sagging of the building wall is believed to have caused a short circuit in electrical wiring. (See April 1944 *Quarterly*.)

Acme

Lack of fire divisions played an important role in the total destruction of this pier in New York City destroyed on January 8, 1942. The pier structure, of combustible roof and floor construction, was 570 ft. long, without fire divisions in either the pier shed or in the substructure. Today, port facilities are particularly important as the U. S. A. implements Marshall Aid and the Atlantic Defense Pact. (See April 1942 *Quarterly*.)

Subdivision of Areas and Materials

Often the simplest and least expensive method of assuring reasonable fire safety is subdivision so that a fire in any one part of a factory or warehouse can cause only a very small percentage loss even assuming no fire fighting. Subdivision of values, spacing of piles of raw materials and, better still, planning storage and manufacturing facilities in small separate units placed in different cities or different parts of the country is an excellent safeguard against total fire destruction. It is equally effective against the results of accidental fire, those due to sabotage or any form of enemy action.

During World War II, it was a common tendency of both the military services and a number of industries to create "specialized storage depots" which concentrated all, or a major portion, of one essential commodity in one location. Done to ease filling orders, it nevertheless put "all the eggs in one basket" to a degree which gave many fire protection engineers sleepless nights.

Subdivision of manufacturing and storage facilities may result in some sacrifice of efficiency. With mechanical handling equipment and production line facilities, the individual units are often necessarily large in order to secure maximum efficiency. The apparent efficiency of large-scale units however, seems less important when all factors are evaluated, particularly the possibility of complete destruction of the entire property by a single fire either of accidental or enemy origin. Fortunately, through the application of fire protection engineering judgment, it is frequently possible to design both manufacturing plants and storage facilities in such a way as to minimize the amount subject to destruction in a single fire and at the same time maintain high efficiency of operation.

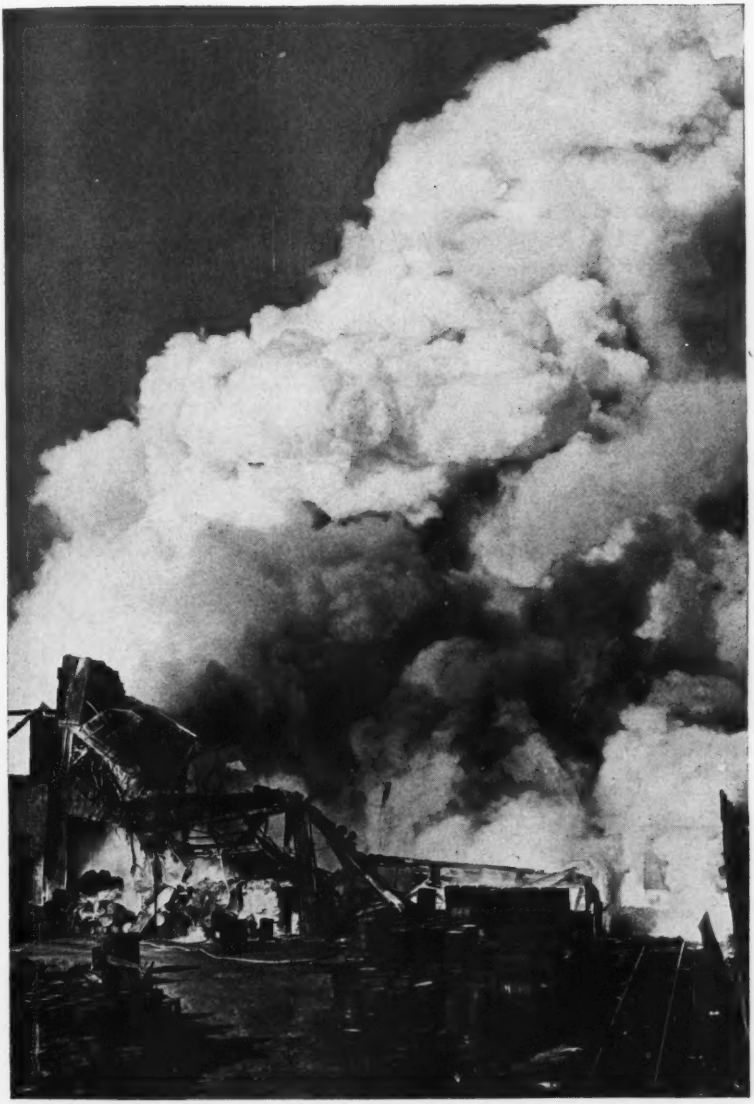
San Francisco Chronicle

Automatic fire protection was not available to stand guard at this plant in Oakland, Calif. on February 28, 1943. Had such protection been provided, it would undoubtedly have been of greater service to the war effort at that critical time than the soldier photographed here guarding the remains of the $3,000,000 loss.

structure, of combustible roof and floor construction, was 570 ft. long, without fire divisions in either the pier shed or in the substructure. Today, port facilities are particularly important as the U. S. A. implements Marshall Aid and the Atlantic Defense Pact. (See April 1942 *Quarterly*.)

Providence Journal

Lack of subdivisions in this fire subjected a 640 ft. by 200 ft. shipyard fabrication shop to a heavy loss in Providence, R. I., on December 31, 1942. Actually, the fire originated in a small furnace room which was located in a small wing to the main building and had this portion of the property been properly segregated the loss might well have been a few hundred dollars instead of an estimated $1,000,000, not counting the setback in war production.



Large stocks of magnesium scrap and turnings, stored in piles, drums, barrels, bags, cartons and other containers, subjected the National Smelting Company plant to a $250,000 loss on July 27, 1944. It was embarrassing to the war effort to have this important plant crippled by a fire in scrap materials just because of the poor storage methods and lack of structural subdivisions. (See October 1944 *Quarterly*.)

31, 1942. Actually, the fire originated in a small [illegible] the property been properly segregated the loss might well have been a few hundred dollars instead of an estimated $1,000,000, not counting the setback in war production.

Liberty, as well as Liberty Ships, was placed in jeopardy when fire dealt a knock-out blow to the Iron Fireman Manufacturing plant in Portland, Oregon on February 2, 1944. Originating in a trash collection, discovered when it was no larger than "a bushel basket," lack of automatic sprinkler protection proved to be a serious omission and the U. S. Maritime Commission contract for Liberty Ship engines temporarily became valueless.

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Self-Sufficient Plant Fire Protection

In designing manufacturing and storage facilities to withstand the possible impact of wartime fires every effort should be made to make the individual facility self-sufficient as far as possible, recognizing the fact that in case of enemy attack the public fire department may be unavailable, public water supplies may fail due to the rupture of water mains by bombs and electric power to drive fire pumps may not be available when transmission lines are down. All these factors point to the importance of self-contained fire protection programs for individual plants, particularly where they are of large size.

What can be done in each individual case is a matter of special planning, but every manufacturing and storage facility can to some extent be improved in its fire safety even under the most adverse conditions of enemy attack. In the case of the larger plant, water supplies may be provided by local gravity tanks and by internal combustion engine driven fire pumps, making the plant water supply for fire fighting independent of any outside source. Likewise, the organization of a plant fire brigade, fire guards and other first aid fire-fighting facilities can contribute greatly toward the fire safety of the plant. Most of these special wartime plans are equally effective in improving fire safety under peacetime conditions, and intelligent application of the accepted principles of peacetime fire protection will go a long way towards providing an adequate program of fire defense in time of war.

Current urging by the National Security Resources Board and other Civilian Defense agencies and experts (see article, this *Quarterly* by Dr. Lapp) to decentralize industry and disperse facilities makes self-sufficient plant fire protection an urgent requirement. This fact has already been observed in NFPA fire record data and was discussed at the 1950 NFPA Annual Meeting (see Proceedings, pages 78-81).

Protection of Vital Records

It is not possible in every case to provide complete preparedness. Carried to its extreme this would mean locating all our facilities underground and also having the entire population live underground, for we must not lose sight of the fact that factories cannot produce without skilled personnel for the operation of machines. Perhaps certain critical processes should be thus safeguarded, but it is obviously impractical to provide complete protection for every manufacturing process that might be a factor in the war effort.

One thing which can be done in every case is to have a program for the prompt reconstruction of any individual facility that may be destroyed by fire. The essential factor of any such program is provision of the "know-how" of the operation by having adequate records, including all blueprints needed for prompt restoration of the occupation after either an accidental fire or an enemy attack. This means a systematic plan for protection of records either placing them in fire-resistive safes or vaults or having duplicate information at other locations.

Indications are that vaults specified in the NFPA Standards on Protection of Records should provide adequate protection for their contents in case of any reasonably anticipated enemy attack short of a direct hit of an atomic bomb or a large high-explosive bomb. Emphasis should be placed upon reinforced concrete and other forms of construction which employ a considerable degree of structural strength to resist the shock of an explosion rather than ordinary types of un-reinforced

International

Employee training and organization of fire brigades was shown to be woefully overlooked when the famed *Normandie* burned and capsized at its pier in New York City on February 2, 1942. In the NFPA report of this disaster in the July 1942 *Quarterly* details of employee unpreparedness and unorganized fire fighting illustrate how serious was this shortcoming.

International

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Employees were reported to have smelled smoke as much as two hours before the fire alarm was transmitted to the Pittsburg Fire Department on April 6, 1943. When they arrived they were confronted with a fully charged building and the war was over for this storage facility. A few untrained "home-front" soldiers fell down on the job.

Complete loss of administrative records was experienced in this fire which leveled the Administration Building of the Douglas Aircraft Company plant in Park Ridge, Ill., on July 18, 1944. Wood construction used in the 605 ft. by 134 ft. building created an inferno and the structure collapsed, burying the important records of this war-born plant.

masonry which may have adequate fire resistance but has limited resistance to shock.

Utilization of Trained Personnel

The entire field of fire safety has direct application to war preparedness. As in any other field, the most important element in fire protection is the technical "know-how," and in any preparedness plans adequate provision should be made for utilizing to the best advantage the technical knowledge and experience possessed by our fire protection personnel.

During the last war we failed to make the best use of our technical "know-how" in the fire field. We took experienced men out of fire departments and placed them in military service where they had no opportunity to use their experience while at the same time we were taking other men lacking any fire-fighting experience and going to great lengths to train them in the techniques of fire fighting. We took trained fire protection engineers who before the war had been devoting their lives to engineering studies of the hazards of manufacturing plants and devising methods for minimizing fire losses, put them in uniform, gave them certain military training, and then put them in other parts of the country inspecting different types of factories for fire safety.

Anyone concerned with fire protection matters during World War II can cite numerous instances of wasted effort all due fundamentally to the fact that important policy decisions on fire protection matters were in many instances made by men who lacked any experience or knowledge in the field of fire protection and who did not even recognize that com-

Trained fire protection engineers could have given advice to the Hammer Dry Plate Co. about the proper safeguards in handling nitrocellulose film. The Army, for whom the work was being done, could have insisted that these recommendations were followed. While the Missouri Inspection Bureau had supplied the guidance, the recommendations were not followed and the entire plant and a huge quantity of Army film were destroyed on February 3, 1943.

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Another case where a little fire protection engineering advice would have aided the war effort was evident in this fire which destroyed the Austin Bridge Co., near Dallas, Texas on Dec. 15, 1943. At the time, the plant was producing magnesium bomb casings. A plywood ventilation duct to carry off fumes of sulphur dioxide used in the process was ignited during a dinner period and fans spread the flames against the wood structural elements to go beyond control of first aid appliances which were all that was available.

petent, expert advice in this field was available for the asking. Many lessons were learned in World War II, and towards the end of the conflict fire matters were better organized in many phases of our military and defense production operations.

If the experience of the last armed conflict can be effectively utilized, we should be in a far better position fire-wise to meet any future war. However, this result can be achieved only through the cooperative efforts of all members of the National Fire Protection Association and others who appreciate the seriousness of the threat of fire and have the "know-how" to meet it.

Star-Ledger

Proper utilization of fire protection engineering services might well have prevented this fire at the Congoleum-Nairn plant in Kearney, N. J., on August 19, 1943. For the war, the concern shifted production from linoleum to camouflage materials. The processing hazards changed and failure to safeguard the vapors of naphtha caused an explosion which resulted in a $2,000,000 loss which could not be camouflaged.

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New Forms of Building Construction

By B. L. Wood

Consulting Engineer, American Iron and Steel Institute

Advances in the technique of building naturally tend to make old standards and regulations obsolete and cause long-accepted standard requirements to acquire restrictive meaning not contemplated when they were formulated. Standards and rules founded on building customs and practices in vogue when they were originally written, may have served their purpose well over the years; but when applied to today's constructions, they often become unreasonable, and do not reflect our present knowledge of the severity of the hazards to be met. Today, performance standards are superseding the old descriptive requirements.

In the development of new building constructions, engineers — very rightly — are concerned over strength and structural adequacy. But, if we contrast the few structural failures that occur with the heavy toll collected by fire every year, we begin to realize how important the subject of fire safety really is. The science of fire-protection must keep step with the advances made by building construction if we are to take full advantage of those advances and reduce the already serious annual losses from fire.

How can we achieve greater fire safety without increasing building costs, which already are too high? The answer is by utilizing the knowledge of fire hazards and fire protection, gained during recent years, to correlate the degree of fire protection sought with the actual risk, thereby avoiding unnecessary and unbalanced requirements that add more to costs than they do to safety.

We now have factual data that enable us to correlate the combustible contents with the severity of fire hazard that prevails in typical occupancies for which buildings are used. Thus, we are able to evaluate the risk and determine the degree of fire protection that will afford reasonable safety for occupants and structure. Costly, unbalanced fire-protection requirements can be avoided, and greater uniformity of safety achieved. Improved fire safety does not necessarily connote higher building costs.

Let us examine some of the newer forms of construction and see how economy can be achieved, without sacrifice of safety, by relating the degree of fire protection they afford to the severity of the fire hazard likely to prevail where they are to be used.

Modern production and manufacturing methods now have made economically feasible the use of light, cold-formed steel panels for walls, floors and roofs of buildings. Many industrial buildings, some literally a mile long, with scores of acres of floor space, have been built of light steel construction, enclosed within wall panels of light, formed steel. Within their structural limitations, such steel constructions, formed of steel about 1/16 inch in thickness, are exerting increasing influence on the design of future buildings.

Floor and Roof Construction

The skyscrapers of the future probably will follow the general structural pattern of the past, with welding superseding riveting, and designers taking advantage of

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This article is based on an address given by the author before a joint Fire Insurance Underwriting Engineering Conference of the American Mutual Alliance in New York City, May 10, 1950.

the continuity of the structural members; but major innovations are being effected through the use of constructions formed of light gage steel for floors, roofs, and exterior walls. The advantages are obvious: reduction of the weight to be supported by the framing and the foundations, speed of erection, and reduced costs.

New impetus has been given to the use of structural members formed of flat-rolled steel through the development of rational design methods. The American Iron and Steel Institute in 1939 inaugurated a research program at Cornell University, involving tests of nearly 1,000 specimens, which resulted in the publication in 1946 of a design specification, supplemented in 1949 by a "Light Gage Steel Design Manual." That specification now is nationally recognized as a design standard and has been adopted as the basis for approvals by most cities.

These new floor constructions consist of individual steel joists spaced at relatively close intervals, generally not over 24 in. on center, or of cellular panels formed of flat-rolled steel, spanning between the main girders or walls. They are practicable and economical for use on ordinary spans for live loads up to about 125 pounds per square foot, and often for somewhat heavier loads. These constructions generally have a light-weight concrete fill or a thin 2 in. or 2½ in. concrete top slab, and are protected by a fire-resistive plaster ceiling applied on metal or wire lath, attached to their underside.

The greater the number of stories in a building, the greater the importance of reducing the dead weight of the floor system and the greater the advantages of these lightweight floor systems. Hence, they have been used in many of the post-war skyscrapers—the 35-story Mercantile Bank Building in Dallas, the 28-story John Hancock Insurance Company Building in Boston, the 24-story Waterman Steamship Building in Mobile, the Massachusetts Mutual Life Insurance Company Building in New York City, the Grant Building in Pittsburgh are a few examples.

Steel floor or wall panels can be erected quickly; and when in place, each panel constitutes a complete structural unit. A couple of men lift in place a floor panel as quickly as they could a wood joist, but 30 sq. ft. or more of floor area results from the effort. A deck immediately becomes available free from the shores traditionally required to support the formwork affording clear working space for the other trades and sub-contractors, and eliminating the fire hazard represented by wood formwork.

An inspection survey of painted, light steel constructions in 50 buildings located in various parts of the United States was made by Pittsburgh Testing Laboratory to determine their condition, with particular reference to the effectiveness of the paint protection and their durability under service conditions. The report was published in 1942 by the American Iron and Steel Institute; the survey indicated that the installations generally were in excellent condition, all were structurally sound and had been effectively protected by the original shop coat of paint.

Fire Protection Qualifications

Question naturally arises concerning the fire-protection qualifications of these light steel floor constructions. The adequacy of those qualifications can be determined only as we are able to evaluate the severity of the fire hazards in the several occupancies for which those constructions are likely to be used.

Surveys, conducted under the direction of the National Bureau of Standards, show

that in hotels, apartments and similar residential occupancies, in schools, hospitals and similar institutions, the fuel content of the furnishings is relatively low, averaging not over 5 to 10 lbs. per sq. ft. of floor area. That fuel content is equivalent to ½- to 1-hour severity of fire hazard, as measured by the standard fire test* exposure on which the fire resistance of building materials and constructions is rated.

In office and similar business buildings, the survey indicates a somewhat higher fuel content, about 10 to 15 lbs. of combustibles per sq. ft. of floor area, representing a fire hazard equivalent in severity to 1- to 1½-hours of the standard fire test exposure.

In stores and mercantile establishments, the fuel content and the fire hazard averages still higher, representing about 1½- to 2-hours of the standard fire exposure.

In industrial occupancies, the fuel content is likely to vary over a wider range, but the indications are that the contents of the average industrial occupancy represent about 2½-hour severity of fire hazard or less. Storage occupancies are likely to involve somewhat higher fire hazard severities.

These values do not include the fuel content of the structure housing these occupancies. If the structure is of combustible construction, it will contribute about 15 to 20 lbs. of fuel per sq. ft. of floor area, in addition to that involved in the contents of the occupancy often trebling the fuel content of the occupancy and increasing the severity of the potential fire hazard.

Thus, we find that for fires originating in occupancies such as residential, school, institutional, business and mercantile uses, non-combustible types of construction that provide 2-hours fire resistance under the standard fire test may be expected to survive the exposure structurally intact. For ordinary industrial occupancies, constructions affording 2½- to 3-hours fire resistance may be expected to withstand succesfully any fire that is likely to occur.

More standard fire tests have been made on light steel assemblies, probably, than on any other type of construction. The resultant standard ratings have been published in Bureau of Standards Report BMS-92. Those ratings and data on fire hazards are summarized in "Fire Protection Through Modern Building Codes" published by American Iron and Steel Institute.† The performance of the light steel assemblies under those fire tests has been remarkably consistent and does not suffer by comparison with the older conventional types of "fireproof" construction. Incidentally, data on the fire resistance of many of those older types of construction are lacking, and only "estimated" fire ratings are available for them.

Where light steel floor assemblies are protected with a ¾ in. sanded gypsum plaster ceiling of the usual plaster mix (1 to 2; 1 to 3), applied on metal lath attached directly to the underside of those constructions, fire resistance ratings of 1- to 2-hours are developed, the variation in rating depending upon whether or not a top slab of concrete, 2" thick, is installed. That degree of protection is adequate for the severity of hazard involved in the residential, school, institutional, business and mercantile occupancies previously cited.

For the occupancies of higher hazard and for buildings of unusual height and size, where so-called "fireproof construction" is generally specified by the building

*See National Fire Codes, Vol. III.

†Single free copies available to NFPA members from the Institute, 350 Fifth Ave., New York 1, N. Y.

code, the fire resistance ratings of these light steel constructions can be increased to 3- or 4-hours, or more, by using ceilings of richer mix or greater thickness of plaster, or by substituting vermiculite* or perlite* for sand in the plaster mix.

Both gypsum-vermiculite and gypsum-perlite plasters are light in weight, easy to apply, and afford a high degree of fire resistance. Their cost is little higher than sanded-gypsum plaster. They are coming into popular use. Our old concept of "fireproof" structures—heavy members of concrete or encased in concrete—is undergoing a change.

Where the required degree of fire resistance is provided by a protective ceiling, encasement of the individual structural members becomes unnecessary and is not required by modern building codes or standards, except for members that support load from more than one floor or roof.

Ducts for heating, air conditioning, or similar purposes, often are installed above protective ceilings. Such ducts should be of non-combustible construction and should be provided with automatically operated metal dampers to prevent spread of fire and hot gases in the event of a fire. These fire safety measures are necessary irrespective of the type of floor system or building construction. But since these duct systems often have ceiling outlets, question naturally arises concerning the effect of ceiling openings on the degree of fire protection afforded by a ceiling. Obviously, an answer to that question must be related to the aggregate size or magnitude of those openings.

*Vermiculite aggregate is obtained by subjecting vermiculite, a laminated micaceous mineral to high temperatures. Perlite aggregate is obtained similarly from perlite, an igneous glassy rock, which divides into small spherical bodies upon cooling.

A standard 3-hour fire test recently was conducted by Underwriters' Laboratories on a light steel cellular floor construction protected by a plaster ceiling which contained openings larger in size than those likely to be encountered in actual building practice. The test showed that openings aggregated 100 sq. inches per 100 sq. ft. of ceiling area did not impair the fire resistance rating as compared with a previous test of a like steel assembly protected by a similar ceiling that had no openings.

The construction successfully supported the full design load (145 lbs. per sq. ft.) during the fire test; and, after the standard fire test exposure, supported an increased load of 245 lbs. per sq. ft. (combined dead and double live load) without signs of distress.

Thus, the present trend toward the use of light steel floor and roof assemblies, protected by fire resistive plaster ceilings, offers obvious advantages: Effective fire protection, adequate strength, quality finish, lightweight, speedy erection and economy.

Interior Finishes

After gypsum plaster came into general use, the interior finish of buildings involved little fire hazard. Now, however, that situation has changed. Many new types of finishing materials have been developed in recent years, some of which are highly combustible and have already proven dangerous for use. These dangerous finishes can render any building unsafe for its occupants, as recent disastrous fires have demonstrated*. Fires can kill people without causing serious damage to the structure.

The degree of hazard represented by the various kinds of finishing materials, now

*See NFPA *Quarterly*, October, 1949.

available for use, covers a wide range. Some combustible materials are reasonably safe for use, some really dangerous. But, although this is a feature closely related to safety of life, our building codes, to date, deal with it neither adequately nor rationally.

It has been code practice to regulate finish only in places of assembly and in fireproof buildings, and there to the extent of prohibiting from use *all* combustible finishes irrespective of the degree of hazard represented. The occupants of hospitals, sanatoriums, hotels, lodging houses, apartments, loft buildings etc. are afforded no protection. Finishes considered too dangerous for use in a fireproof building are permitted in buildings of wood-frame construction, although obviously they are no less dangerous when used in the latter.

Rational regulation of interior finish must evaluate not only the degree of combustibility of the material but also the degree of danger it represents in the place where it is used. A combustible finish, reasonably safe for use in an office occupancy, is less safe when used in a hotel, and probably is too dangerous for use in a hospital. Thus, for equalization of risks, the regulations for each kind of finish should vary according to the occupancy or use. Unnecessary restrictions on the less-hazardous kinds of combustible finish should be avoided so their economies may be made available within a scope of use consonant with safety.

The Underwriters' Laboratories have developed a tunnel test* for evaluating the relative hazard of interior finishes. That test duplicates the conditions of a vigorous incipient fire and rates the materials according to the time and extent of flame development along the surface of the test sample during the controlled standard fire exposure. The test procedure recently was voted as a tentative ASTM standard by ASTM Committee E-5.

Materials rated according to the tunnel test method fall into five general classes, as follows: into Class I (Noncombustible) fall gypsum plaster, foam glass, asbestos-cement and similar non-combustible materials; into Class II (Fire Retardant) or Class III (Slow Burning) may fall protectively treated wood; into Class III (Slow Burning) falls protectively treated canvas, treated cellulose board, and treated plywood, into Class IV (Combustible) falls untreated woods and untreated plywood of exterior grade and of 10 cycle (alternate wet and dry) interior grade; into the more hazardous Class V falls untreated cellulose boards of low density, untreated wood veneers, and untreated canvas, materials that involve a higher hazard than pitchy pine.

Application of this yardstick in regulating the allowable use of the different finishes, as might be expected, creates differences of opinion. Certainly, however, use of safe finishes (such as Class I Noncombustible and Class II Fire Retardant) should be required in all exitways and in all hospitals and institutions where occupants are under restraint or suffer physical disabilities. Further, it is obvious that Class V hazardous, combustible finishes are dangerous for use in *any* occupancies. In between these two extremes of regulation, upon which there is pretty general agreement, restrictions on the scope of use to be allowed the intermediate classes of combustible finish must rest on judgement. In all occupancies, if the occupant content is above average, say over 40 persons, the use of combustible finishes which are ca-

*See NFPA *Quarterly*, July, 1943

pable of spreading fire or toxic gases rapidly should be restricted. For those who are interested, suggested limitations of use for interior finishes appear in my book "Fire Protection Through Modern Building Codes," previously cited.

Exterior Walls

Today, as 100 years ago, the exterior walls of most of our buildings consist of millions of little clay units, each one carefully placed by hand, after it has been painstakingly buttered with mortar. This process has become increasingly more costly. The results: walls that are thick, heavy and often leak. Their function: to keep out the weather and provide a reasonable degree of insulation and fire protection.

All those functions can, in the future, be performed by thin, insulated metal-clad wall panels. These panels, now coming into use for non-load-bearing exterior walls, reduce substantially the weight to be supported by the framing and the foundation, important items costwise. They are weathertight, afford equivalent or better insulation than masonry, and provide the necessary degree of fire protection; speed of erection is another important, favorable factor. Also, their reduced thickness affords ½ sq. ft. or more of additional rentable floor space per running foot of exterior wall. It is estimated that thin, insulated curtain walls would have added between 2 and 3 per cent to the rentable floor area, had they been used in Rockefeller Center.

In the buildings of the future, panels of stainless steel, porcelain enameled steel, aluminum and other metals will be no less attractive architecturally than the present masonry walls.

The old requirement of building codes that exterior walls must be of masonry construction of some specified thickness or of 4-hour fire resistance reflects the established building practices of the past. This requirement now needs re-examination. It stands as a road-block to progress in the use of newer types of wall construction, not masonry, irrespective of their serviceability qualifications.

Modern codes relate their requirements to actual safety needs, and specify performance standards accordingly. Building costs are too high today to tolerate code requirements that are unnecessarily severe and restrictive.

Modern fire protection standards now evaluate the outside exposure from fires in closely adjacent buildings as seldom exceeding in severity the corresponding exposure from a 2-hour standard fire test and as decreasing rapidly in severity as the distance of separation from exposing fire increases. Those standards also take cognizance of the structural function which the exterior wall performs, and differentiate accordingly in the fire resistance requirements. An exterior wall that supports the structural framing of a building is far more important to the structural integrity of a building than a wall that supports no load but serves merely as a panel or curtain wall and is supported at each floor level. The fire protection requirements for the former, very properly, should be higher than for the latter.

The panel or curtain walls (non-load-bearing) generally contain, or are permitted to contain, window openings. Such openings, even when protected by fire windows of wired glass in steel sash, are capable of developing only about ¾-hour fire resistance, beyond that glass melts. Ordinary plain glass windows with wood sash develop only a couple of minutes resistance to the passage of fire or hot gases.

As the older building regulations were written, glass windows of unlimited size

were allowed. (The new United Nations building has all-glass walls on two sides.) But if a solid wall was used, it had to be of masonry and have 4-hours fire resistance. Thus, under the older codes, a building could have either 4-hour protection or 2-minute protection against spread of fire, hardly a rational procedure.

Modern regulatory procedure is more rational. Codes are now being written to require *2-hour* non-combustible construction for non-load-bearing panel walls in those locations where fire windows or shutters are required, but to permit *1-hour* non-combustible construction for panel walls in locations where (because of street frontage or wide separation from property lines and adjacent structures) unprotected wall openings are allowed. That procedure follows the modern functional principle, and is a good example of how building costs may be reduced without any actual sacrifice of safety. That type of requirement now has been adopted in the building codes of New York, Chicago, Cleveland and Pittsburgh and in building standards such as the American Standards Association, and the Basic Code of the Building Officials Conference of America.

Metal-clad insulated panel walls are now being developed to meet these new building requirements. These panels, generally about 6 in. thick are insulated with a light-weight, fire-resistant, insulating material. In multi-storied buildings they usually are supported by the lintel or spandrel beams. Where erected vertically, as they are in many one- and two-storied industrial and commercial buildings, the panels are supported at top and bottom and may have an intermediate brace. They are attached solidly to the structural framing to prevent their displacement. Many of the insulating materials suitable for thin, panel wall construction are far more effective as thermal insulators than ordinary masonry—a 4 in. panel often having several times the insulating value of a 12 in. brick wall. Using these panel walls, it is economically feasible to develop 1- to 2-hour fire resistance rating.

Most of the difficulty being experienced by manufacturers in meeting the specified degrees of fire resistance lies in devising joints that will meet the heat-transmission limitation of the standard fire test, without unduly increasing cost. Paradoxically, this feature actually is of minor significance, so far as fire safety is concerned, because heat will be transmitted through the glass window above the spandrel wall much faster than through wall joints.

Progress Depends on Two Factors

Building costs can be lowered without sacrifice of safety, but the rate of progress in that direction will depend not only upon rationalization of our building laws but also upon the cooperation of those who write fire insurance and establish the premiums to be assessed against our buildings. Insurance rating schedules must be rationalized so that new forms of construction are rated on their merits and their use is not discouraged because of unduly high insurance penalties resulting from outmoded rules.

The fire prevention value of non-combustible construction sometimes is not reflected in relative insurance rates when compared with wood-frame structures that add to the fuel content and potential fire risk. The wood-framed structure itself often contains about three times as much fuel as the contents of the occupancy, whereas the non-combustible structure limits the fuel to the contents of the occupancy. Without fuel fire cannot spread.

Fire Protection on Modern U.S. Passenger Ships

By K. H. Wiley, Engineer
Bethlehem Steel Company, Shipbuilding Division

People who read head-lined newspaper stories about fires on passenger vessels may easily get the impression that all passenger ships are fire-traps. Many foreign vessels and some of the older U. S. vessels are admittedly not as well protected as might be desired. However, a modern U. S. passenger vessel, constructed and equipped as required by current Coast Guard regulations,[1] is probably a safer place to be when a fire starts than a large majority of buildings where a comparable number of people sleep or congregate. This is in spite of the fact that a ship at sea must be completely self-sufficient.

Up to about fifteen years ago, marine fire protection requirements everywhere were rather weak and some bad fires at sea resulted. In 1935, stimulated by the *Morro Castle* disaster,[2] the Committee on Commerce of the U. S. Senate, through a subcommittee headed by the late Senator Copeland, initiated an investigation of the legal standards regarding safety of ship construction in this country. The actual investigation was carried out by a "Technical Committee on Safety at Sea."

At that time, the NFPA Marine Committee, which had been quietly at work for several years, completed preparation of a number of marine fire protection standards. Those dealing with ship design and construction, fire detection, alarm, and extinguishing apparatus, among others, were tentatively adopted by NFPA at its annual meeting in May, 1935. Naturally enough, several of the persons named to serve on the government committee had been participating as members of the NFPA Marine Committee and consequently much of the background work then completed under NFPA sponsorship served as a basis for the further studies of the government-sponsored committee.

The portion of this work relating to fire safety was carried out by a technical "Subcommittee on Fireproofing and Fire Prevention" composed of representatives of the industry and various governmental and other regulatory bodies. This subcommittee, under the chairmanship of Mr. George G. Sharp,[3] conducted extensive studies including numerous experimental fires on board the S. S. *Nantasket,* a laid-up ship allocated for the purpose by the Merchant Fleet Corp. These studies resulted in recommended regulations which formed the Fire Control chapter of Senate Report No. 184, submitted for legislative consideration by the Senate Committee in 1937 and published in 1938.

Senate Report No. 184 never became law as contemplated by the Senate Committee. However, the U. S. Maritime Commission immediately adopted it as a requirement on all vessels built in which the Commission had a part-owner interest. The first passenger vessels built to these requirements were the *Panama, Ancon* and *Cristobal,* delivered to the Panama Railroad Steamship Line by the Quincy

[1] See appropriate references in the NFPA Handbook of Fire Protection, Tenth Edition, pages 1229-1230.

[2] See October 1934 NFPA Quarterly.

[3] Member NFPA; Member NFPA Committee on Marine Fire Protection; Chairman of the former NFPA Marine Section Committee on Construction and Design; distinguished Naval Architect and exponent of fire-safe ship construction.

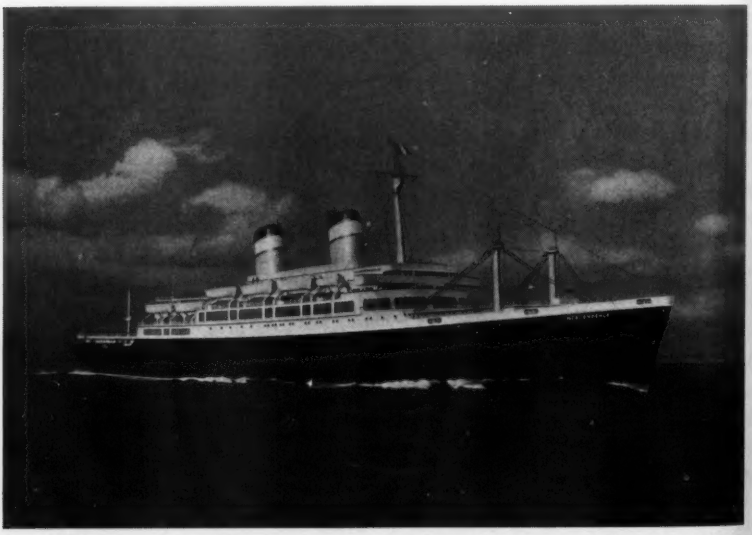
Yard of the Bethlehem Steel Company in 1939. These were soon followed by the *America* built at Newport News for the United States Lines in 1940. The requirements of Senate Report No. 184, as built into these ships, were much more severe than any regulatory requirements existing at that time.

Legislation in 1936 also provided for the reorganization of ship inspection services under the Bureau of Marine Inspection and Navigation. In the early days of World War II, the functions of this Bureau were transferred to the Coast Guard which still retains them. The regulations have been gradually reorganized and the requirements increased to such an extent that now the Coast Guard fire safety requirements for new U. S. passenger vessels exceed, in most respects, other corresponding requirements anywhere in the world. U. S. practice is now so much more rigid than current foreign practice that the diff culty of correlating them at the 1948 "In ternational Conference on Safety of Lif at Sea" led to the adoption of three alte native sets of requirements.[4] These alterna tives are sometimes described as the Amer ican plan, the British plan and the Frenc plan. The American plan is based on th most extensive use of fire resistant con struction and involves materials not s readily available in Europe as in this coun try.

Application to American Export Liner

The Quincy Yard of the Bethlehem Steel Company is now building two 682 foot passenger ships for operation by American Export Lines, Inc. between New York and Mediterranean ports. These ves sels will be known as *Independence* and *Constitution*. Each will be certified to carry

[4]See July 1949 Quarterly for a report of this International Conference (pages 47-52).



Artist's conception of the American Export Liner *Independence* which, with her sister-ship *Constitution* is now under construction, employing extensive fire protection facilities.

more than fifteen-hundred-and-fifty (1550) passengers and crew. They are being constructed with the benefit of subsidy under the direction of the U. S. Maritime Administration (formerly Maritime Commission) and must therefore comply with Senate Report No. 184. They must also, of course, be built in accordance with the latest Coast Guard regulations, regardless of subsidy. Between requirements of the government, the owners and recommendations of the builders, these vessels incorporate some very interesting ship-board fire safety provisions which are discussed in this article.

These features may be classified in three basic categories as follows:

(a) Construction consisting of the use of fire resistant materials.
(b) Detection and Alarm, including methods and appliances.
(c) Extinguishment, including methods and appliances.

Construction

The purpose of extensive fire-resistant construction is to localize any fire at or near the point of inception for a substantial length of time. Thus the master and officers of the ship gain time in which to organize more efficiently the ship's fire-fighting facilities before the fire becomes a general conflagration. In fact, the use of fire-resistant construction and the restrictions on combustible materials are such that many fires in the smaller accommodation spaces would probably burn out and die at the source without any attention.

The vessels are divided into seven main vertical zones by six bulkheads. The superstructure and upper portion of the main hull are further divided by the decks into eight horizontal zones which include all passenger and crew accommodations. Below these are the cargo, fuel, water, stores and machinery spaces. These bulkheads and decks together with more important portions of intermediate bulkheads are of "A" type construction described in subsequent paragraphs. These intermediate subdivisions include bulkheads around control stations, stairway and elevator enclosures, lifeboat stations, motion-picture booths, large public rooms, machinery and cargo spaces, etc.

Further subdivision is of "B" or "C" type construction, also described later. "B" type is used for fire bulkheads of secondary importance, such as those around individual staterooms and other small accommodation spaces. "C" type construction is generally permitted only between spaces which, for fire safety reasons, need not be separated at all.

The more fire resistant types of construction are used to separate larger spaces or those containing larger amounts of combustible material and also those spaces which are of especial importance because they are used for escape or for housing of control equipment and personnel. First and cabin class accommodations have combustible furniture and therefore require more efficient divisions than tourist class and crew accommodations which have non-combustible furniture.

Bulkheads and decks must be capable of withstanding two tests, based on a standard fire test, as follows:

(a) Structural integrity test during which they must prevent the passage of flame.
(b) Heat transmission test during which the temperature on the side away from the fire shall not rise more than 250°F average or 325°F maximum.

The standard fire test, within the limits used in marine regulation, is one which

develops the following temperatures at the end of the times indicated:

5 minutes	1,000°F
10 minutes	1,300°F
30 minutes	1,550°F
60 minutes	1,700°F

The times in minutes for which the various types of bulkheads and decks must withstand the above tests are as follows:

Type	Structural Integrity	Heat Transmission resistance	Construction
A-60	60 min.	60 min.	Steel with non-combustible insulation
A-30	60 min.	30 min.	
A-15	60 min.	15 min.	
A-0	60 min.	0 min.	Steel
B-15	30 min.	15 min.	Non-combustible
B-0	30 min.	0 min.	
C	0 min.	0 min.	

In each main vertical zone there is at least one stairway serving all accommodation and working spaces. Except in machinery spaces, such stairways serving more than two decks are completely enclosed so that escape may be made from any deck to the lifeboat embarkation deck or other weather deck without previously coming out of the stairway enclosure. There is also an additional horizontal or emergency vertical escape, exclusive of elevators, from each horizontal zone within the vertical zone. No combustible material is used in these stair enclosures or passageways.

Doors in any class of fire bulkhead are of a construction consistent with that of the bulkhead. Those in main vertical zone bulkheads and stair enclosures, except power-operated watertight doors, are fire doors of the self-closing type. When normally open, they are capable of being closed simultaneously from the fire control room. All fire doors have hose ports at the lower corner of the door for passing a fire hose. The bottom of each door also has about one-half inch clearance for the full width to allow fire extinguishing water to flow by gravity to lower decks and to drains. The purpose of this drainage is to minimize the accumulation of water with large surface area and large weight on the upper decks where it might cause the ship to capsize through loss of stability. A considerable number of ships have capsized from this cause in the past, one notable example being the *Normandie* in New York harbor.[5]

Ventilation ducts are fitted with automatic dampers where they pass through main vertical zone bulkheads or the bulkheads separating cargo or machinery spaces from accommodations and safety areas.

Such construction features as doors and other closures that require attention in case of fire are described further under subsequent headings.

Fire Detection and Alarm

An electric alarm system is provided consisting of approximately eighty manual alarm boxes and seven hundred automatic thermostats arranged in about sixty alarm zones. Each zone circuit includes one or more manual alarm boxes and from one to about fifty thermostats. Any manual alarm or thermostat operation in a particular zone actuates the corresponding panel of the 60-zone annunicator in the fire-control station and also rings bells in the wheelhouse, the emergency crew quarters and both engine rooms. The system is powered by batteries in the boat deck battery room through a battery-charging panel in the fire-control room.

Spaces protected by this system include accommodation and service spaces, some cargo and stores spaces and isolated spaces housing important machinery such as steering gear and gyro-compass.

[5]See NFPA Quarterly, July 1942. Also see photo this Quarterly, page 110.

Eighty-five watchman clock stations, distributed throughout accommodation and service spaces, are to be patrolled at hourly intervals whenever passengers are aboard. These stations are divided into four routes which are to be patrolled concurrently while one extra watchman is on call in the wheelhouse. The five watchmen will rotate their duties including that of making a joint report to the wheelhouse. They are to have no other duties while on watch. Failure of a watchman to follow the prescribed route, or to record each station within the proper time, is to be entered in the log together with an explanation.

The smoke-detecting system draws samples of air through twenty-six lines of pipe to the detecting cabinet in the Fire-Control room. These pipes collect air from cargo spaces, carpenter shop and certain stores spaces including the paint room. The lower portions of the same pipes also serve to deliver carbon dioxide for extinguishing fire in any space from which smoke is drawn.

Smoke drawn into the cabinet can be detected by sight and smell and will also ring gongs in the Fire-Control room and both engine rooms. This is a standard type of installation in common use on modern cargo vessels. The particular system used in this case is furnished by Walter Kidde & Company. Power for operation is taken from the emergency switchboard or battery.

Film storage for the theatre is protected by four automatic sprinkler heads. This is in addition to thermostats which are part of the electric alarm system described above.

The "general alarm" system consists of more than one hundred bells located throughout the ship and operated simultaneously by a single switch in the wheelhouse. This may be supplemented by the main ship's bell or whistle.

An emergency announcing system operates from a microphone and control panel in the wheelhouse, through an amplifier panel in the fire-control room to fifty-four reproducers. The quantities, sizes and locations of reproducers are as follows:

Number	Size	Location
22	6 in.	Staterooms for crew and officers of emergency squad.
8	9 in.	Midship public spaces on decks where boat and embarkation stations are located.
24	14 in.	At boat and embarkation stations.

Eight of the twenty-four 14-inch reproducers are of the "talk-back" type actuating a reproducer in the wheelhouse. The system is powered from the emergency switchboard in the emergency generator room.

The public address system cannot be considered as part of the emergency announcing system required by the Coast Guard. Nevertheless, it is on the ship and therefore could be used to supplement the emergency system if it ever became necessary. This system operates from microphones in the wheelhouse and purser's office to fourteen groups of reproducers in passenger and crew public rooms throughout the ship. The system has a silencing switch in the wheelhouse and is powered from the emergency switchboard.

In connection with the main carbon dioxide extinguishing system described later, release of this gas to cargo holds or machinery spaces actuates pneumatic switches which in turn register separate alarms in each main engine room and on the annunciator panel in the fire-control room. Pneumatic switches in the emergency-generator, gyro-compass and motion-picture projection rooms are also actuated by gas release from the independent systems in these

spaces. These switches sound alarms in the same locations as the main system alarms. Circuits are powered from the emergency switchboard.

Release of gas in the engine room and auxiliary machinery space also causes pressure-operated siren alarms to sound in the space to which gas is released. The above alarms are necessary for the protection of crew because of the suffocating properties of carbon dioxide gas.

In connection with the use of watertight power-operated doors as fire doors, the closing of any of these doors from a remote control is preceded by sounding of an electric alarm at the door. The watertight door control panel in the fire-control room shows a green light for each open door and a red light for each closed door. Other remote operating stations have mechanical indicators showing whether their corresponding doors are open or closed.

Fire Extinguishing Equipment

Water supply at sea is obtained from two fire pumps in the forward engine room and one in the after engine room, each pump being connected through a cut-out valve to the firemain. For auxiliary water supply in port, six 2½-inch double shore hose connections, with adapters, are provided, one each on the weather deck forward and aft and four in way of side-ports three decks lower.

The number and type of outlets are as follows:

No.	Size	Type	Hose (ft.)	Space
88	1½"	Double	75	Accommodation and service
17	2½"	Single	50	Open deck
6	1½"	Single	50	Engine rooms and auxiliary machinery space

Outlets generally are located in fire-station cabinets in well distributed locations. Some cabinets also contain fire axes and portable extinguishers as described later. Outlets in the two engine rooms and the auxiliary machinery space consist of two in each space and are equipped with spray nozzles.

The main CO_2 supply consists of sixty 50-pound cylinders located on one of the lower decks just forward of the forward engine room. This supply can be used as follows:

(a) Simultaneous manual release of the total supply to either engine room from a pull-box at the respective engine room entrance.

(b) Manual release of individual cylinders or groups of cylinders to the auxiliary machine space.

(c) Manual release of individual cylinders or groups through a control manifold on the main deck to any of the cargo and stores spaces connected with the smoke-detecting cabinet in the fire-control room. Between the main-deck manifold and the spaces protected, the same pipes serve for both smoke detecting and CO_2 discharge.

CO_2 release automatically operates pneumatic switches in the CO_2 room which in turn sound alarms in the engine rooms and fire-control rooms and shut off ventilation. The latter restricts the supply of air which would support combustion and cause drafts to spread fire. Discharge of CO_2 to machinery spaces also actuates pressure-operated siren alarms, as stated previously.

Local self-contained carbon dioxide piping systems, independent of the main system, are provided with capacities and in locations as follows:

(a) Five 50-pounds cylinders for the emergency generator room in the upper superstructure.

(b) One 50-pound cylinder for the gyrocompass room below the wheelhouse.

(c) Two 50-pound cylinders for the motion-picture projection room on the theatre stage.

Each of the independent systems is operated by a pull box outside the space protected. The release of CO_2 operates pneumatic switches which sound alarms in the fire-control room, both engine rooms and the space protected, as well as shutting off ventilation to the space.

Each main boiler room is equipped with a CO_2 hose reel unit. Each unit consists of reel, fifty feet of hose, discharge horn and two 50-pound cylinders.

Film storage room for the theatre is protected by automatic sprinklers as previously mentioned. This consists of four sprinkler heads connected to the sanitary salt-water system.

Two portable 15-pound CO_2 extinguishers are located in the main engine room and one in or near each refrigerating or other auxiliary machinery space, theatre stage and automobile hold. Eight 15-pound CO_2 extinguishers are also distributed among three galleys.

About fifty portable 2½ gallon soda-acid extinguishers are located throughout the accomodation and deck spaces, one each in approximately half of the fire station cabinets.

Fire Doors and Watertight Doors

About one hundred fire doors, held open by electro-magnets, can be released simultaneously from a push-button in the fire-control room. This release is accomplished by de-energizing the magnets which remain dead until re-energized from another push-button. In the meantime, these doors act like other self-closing fire doors. There are nearly as many of the latter which makes a total of nearly two hundred fire doors exclusive of watertight doors. Those held open by magnets have local release in addition to the remote control.

Thirty-five power-operated watertight doors also serve as fire doors and can be closed either singly or simultaneously from a control panel in the fire-control room. They can also be closed singly at the doors or at remote control stations above the bulkhead deck. Individual doors may be opened locally for escape purposes and will then close again automatically. Alarms and indicators associated with these doors are described previously under "detection and alarm."

Ventilation Shut-off and Closures

An important aid to fire extinction consists of reduction in the air supply since air is necessary for combustion. Air supply and drafts can be considerably reduced by shutting off mechanical ventilation as follows:

(a) Ships ventilation, excluding cargo and machinery spaces, is shut off manually from one switch in the fire control room or one switch in the CO_2 control room on the main deck.

(b) Emergency generator, gyro-compass and projection rooms and auxiliary machinery space are all included with ships ventilation in the above manual shut-offs. Each also has its respective ventilation system shut-off automatically with the release of CO_2 to that space.

(c) Each main machinery space may have its ventilation shut off manually at the corresponding CO_2 release station outside the machinery space entrance. It is also shut off automatically with the release of CO_2 to the space.

(d) Ventilation shut-off described above consists of shutting-off motor-driven fans. This in turn will cause automatic dampers to close. These dampers are fitted wherever vent ducts serving cargo or machinery spaces enter accommodation or safety areas. Manual dampers are also fitted in many ventilation systems in addition to several magnet-held dampers released with fire doors.

Miscellaneous Equipment

Fire axes, flame safety lamps, oxygen breathing apparatus and a special gas mask for refrigerants are furnished and located as required by the Coast Guard. A suitable quantity of spare charges are also furnished for portable extinguishers, breathing apparatus, etc.

Fire Control Supervision

The nerve center of fire-control activities is the fire-control room in association with the adjacent wheelhouse. Control equipment in one or the other of these spaces includes the following:

(a) Fire alarm annunciator
(b) Fire alarm bell
(c) Smoke detection cabinet and CO_2 release annunciator
(d) General alarm button
(e) Emergency announcing equipment
(f) Public address system
(g) Firemain pressure gauge
(h) Fire door controller
(i) Watertight door control cabinet
(j) Ship's ventilation shut-off switch
(k) Battery charging panel
(l) Emergency and service lighting panels
(m) Power-failure alarm
(n) Breathing apparatus and flame safety lamp

Auxiliary control equipment is also located at the CO_2 control station on the Main Deck, at the entrance to main machinery spaces, in the CO_2 room and at various other local points as mentioned in preceding pages.

A substantial portion of the crew are to be organized into an emergency squad, including some officers and petty officers. This emergency squad will be the first ones assembled in case of fire. To facilitate this, certain staterooms will be allocated permanently to the emergency crew and fitted with fire-alarm bells and loud speakers connected to the emergency announcing system.

In case of fires too serious for the emergency crew to handle, a general alarm summons all the crew. Instructions will be prepared before the ship sails and posted in crew quarters and other conspicuous parts of the ship. These instructions will specify the stations and duties of each member of the crew in case of emergency and describe the fire alarm and other emergency signals. The Coast Guard requires that the crew hold frequent fire drills which must include operation of doors and the use of fire hose and other special equipment. A description of each drill, including the equipment used, is required to be entered in the ship's log. Duties of the crew, in an emergency, include the direction and instruction of passengers.

Conclusion

It is hoped that the foregoing pages will give readers from outside the industry a general picture of the improved fire safety standards now in common use on modern U. S. passenger vessels. In this connection, it might be noted that other aspects of ship safety in this country have also improved to a comparable extent. Another important point is the fact that safety characteristics of passenger vessels are generally more pronounced on the larger vessels engaged primarily in the carriage of passengers rather than cargo.

Army Warehouse Fire, Voorheesville, N. Y.

Fire caused property damage estimated at more than $2,500,000 at the Army Depot, Voorheesville, N. Y., June 17, 1950. On April 23, 1945, this same depot experienced a $1,000,000 fire. In a report of the more recent fire the opinion has been expressed that sprinklers would have prevented the disastrous extent of both fires.

Construction and Contents

Warehouse No. 5 was 960 ft. long by 180 ft. wide, of brick, wood-truss construction with tar-covered roof. A 60-ft.-wide wooden monitor extended along the center of the roof its entire 960 ft. length. Only one-fourth of the 172,800 sq. ft. building was involved in this fire, due in large part to three 12-inch brick fire walls that divided the structure into four 240 ft. by 180 ft. fire areas. Rolling steel fire doors protected the two openings in each fire wall and fire walls extended through the monitor and were parapeted. However, wings were not built out from the fire walls between the main roof and the monitor roof to prevent spread of fire around the fire walls at the monitor.

The fire area destroyed was located at one end of the warehouse and was known as unit 4. Contents of the unit consisted of general engineer troop supplies that had been in dead storage for about three years except for eight carloads of industrial fibreboard delivered three days prior to the fire.

Fire Protection

Fire protection was provided by the Post Fire Department consisting of three chief officers, 20 firemen, a trained auxiliary fire fighting brigade, two 750 gpm pumpers and two 500 gpm reserve pumpers. At the time of the fire one chief officer and eight firemen were on duty.

Acme

Ruins of unit 4 of Warehouse 5 at the Army Depot at Voorheesville, N. Y., destroyed June 17. Flames driven by a 40 mph wind threatened Warehouse 6 (center foreground), and on two occasions spread around the fire wall at the wooden monitor to unit 3 of Warehouse 5. Of the 7,000,000 gallons of water used, more than 5,000,000 gallons were drafted from the creek at left.

Water for the Depot grid system was stored in a 500,000-gallon elevated tank and a 500,000-gallon underground reservoir. These were supplied through an 8-inch main from a 10-inch driven well and the Watervliet Reservoir by two 350 gpm pumps.

The Fire

At 11:33 A.M. June 17, fire was discovered in unit 4, 18½ hours after personnel of the Depot Fire Department had made the last authorized entry for a fire prevention inspection. Flames were rapidly spreading beyond control when Post firemen arrived and calls for aid were immediately sent to surrounding communities and to the General Depot at Schenectady, 14 miles away. Despite the six additional pumpers, 55 civilian firemen and 35 military personnel that responded, there was no chance of saving unit 4 and all fire fighting strategy was directed toward preventing the 40 mph wind from spreading fire to the seriously exposed Warehouse 6 and to unit 3 of Warehouse 5. Several streams were used to wet down Warehouse 6, others were directed at the fire wall segregating unit 4 from unit 3, and three bulldozers were used to push burning industrial fibreboard and other combustible material away from fire wall. On two occasions fire extended around the fire wall to the monitor of unit 3, but each time extension to unit 3 was prevented by prompt attack with hose streams.

At 8:30 P.M. the large number of hose streams had so severely taxed the water supply that it was necessary to augment the rapidly depleting supply in the reservoir and elevated tank with water drafted by four trailer pumps from a creek running through the Depot. With adequate water supplies thereafter the fire was kept under control and extinguished at noon the following day.

Of the estimated 7,000,000 gallons of water used, approximately 5,300,000 gallons were drafted from the creek. Had this fire occurred during the summer months when the water level of the creek is usually too low for drafting, fire fighting would have been seriously handicapped by inadequate water and the fire quite possibly would have involved exposures.

Dip Tank Fire, Chicago

On June 12 the two-story sprinklered building occupied by the Superior Sleepright Corporation at Chicago was heavily damaged by fire. The loss is an outstanding example of one reason why automatic sprinklers are not always effective in controlling flash fires, and emphasizes the need for adequate automatic protection for dip tanks, segregation of hazardous processes, enclosures at vertical openings and subdivision of large fire areas by fire walls.

The Superior Sleepright Corporation, manufacturers of metal furniture and cotton matting, occupied a group of old 1-, 2- and 6-story buildings. One of the buildings, a 2-story brick, heavy timber structure without basement, 15,000 sq. ft. ground floor area, was destroyed in this fire. Floors were not subdivided and numerous unprotected openings connected the two stories so that the building in reality comprised a single fire area of 30,000 sq. ft.

Notable contents features were three 1,000-gallon open dip tanks containing naphtha base paint. Tanks were not equip-

Based upon report submitted by the Cook County Inspection Bureau.

ped with self-closing covers, hoods or overflow drains and the only special extinguishing method provided was one 2½-gallon foam extinguisher on each tank, arranged to operate automatically. Several drums of paint were stored on the first floor and 50 bales of excelsior on the second. Both floors were protected by a wet pipe automatic sprinkler system supplied by two gravity tanks of 40,000 gallons total capacity and a 3,000-gallon pressure tank.

The Fire

At 2:15 P.M. fire broke out at a dip tank being used to paint springs. Sprinklers in the immediate area operated and the fire department was notified by telephone without delay.

Upon arrival the engine company responding connected a 3-inch hose line to the siamese sprinkler connection, laid two 2½-inch lines equipped with adjustable fog nozzles into the building and directed water spray on the dip tank. With the combined efforts of the sprinkler and hose spray the fire was from all appearances being quickly and effectively confined to the dip tank when an explosion occurred about ten minutes after the fire broke out. Because the building was heavily charged with dense black smoke the cause of the explosion is subject to conjecture, although fire officials believe that either a drum of highly volatile thinned paint burst or fire flashed to another dip tank near-by. Whatever the cause firemen were forced from the building as flames flashed almost instantly throughout the first floor and traveled to the second floor through unprotected openings, one of which was a hole directly above the burning dip tank that had been made by a fire on the second floor, May 5.

All 490 sprinklers in the building fused as fire flashed through the structure, but the water was insufficient with so many heads opening and was soon exhausted even though augmented by the fire department connection.

Five box alarms struck between 2:18 P.M. and 2:49 P.M. brought 27 engines, five ladder and three squad trucks, two high pressure wagons and two water tow-

Wide World

Absence of standard automatic protection for a dip tank was one of the substandard conditions responsible for destruction of this metal working plant at Chicago, Ill., June 12.

ers to the scene, but the fire was well beyond control before any box alarm apparatus arrived and was not extinguished until 4:25 P.M.

The fire department has been commended for its efficient work in preventing a fire of conflagration proportions among the congested, high value industrial buildings in the area. One example of the threat to exposures was the ignition of 500 rolls of paper stored in the open adjacent to the sprinklered 3-story Ajax Paper Box Company building, 400 feet from the main fire. Fire from the burning roll burned window frames and broke glas panes but was prevented from enterin the building by fire department hos streams and the operation of sprinklers.

The estimated total loss is $672,00 which consists of $112,000 building dam age, $285,000 contents damage and $166, 000 business interruption loss at th building of origin and $109,000 damag to exposures — damage that could hav been averted by standard dip tank protec tion. (See NFPA Standard No. 34.)

Warehouse Fire, Portland, Ore.

A large electrical equipment warehouse owned by the Union Pacific Railroad and occupied by the Westinghouse Electric Supply Company was destroyed by fire at Portland, Oregon, August 25. Neglect of three fundamental principles of fire protection — subdivision of fire areas, automatic sprinkler protection in areas used for combustible storage, and employee training for emergency action — were primarily responsible for this disastrous loss.

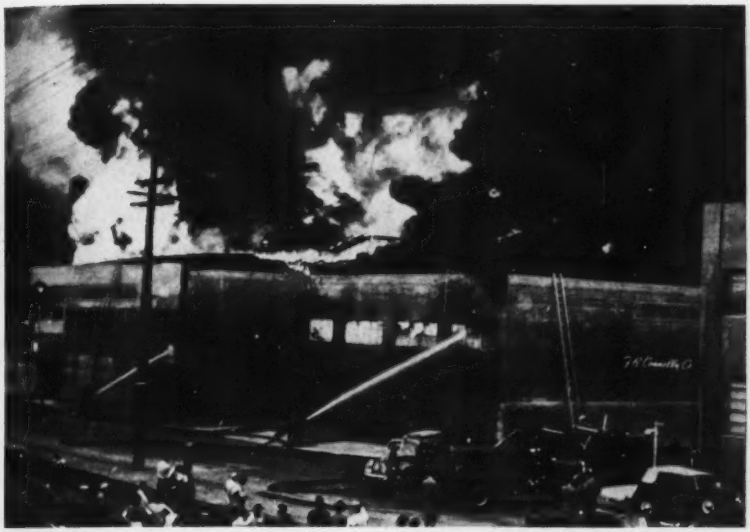
The warehouse destroyed was a one-story structure, 200 feet square and constructed of reinforced concrete walls, concrete floor and wood on wood truss roof. A large shipping doorway in one wall and three smaller doorways in another were the principal exterior wall openings.

Except for a small area occupied by offices and separated by wooden partitions and a suspended combustible ceiling, the building comprised an undivided and unsprinklered 40,000 sq. ft. storage area for various types of electrical equipment and appliances. Refrigerators, stoves and other heavy crated material were stored on the floor, lighter items on steel framed, triple decked, wood slatted racks. In the area where the fire originated, coils of insulated and bare wire in cardboard cartons, waterproof paper or burlap wrapping, were stored on racks. Combustible advertising material was stored on top of the racks.

The Fire

There was no evidence of fire when employees reporting for work at 8:00 A.M. opened the doors and started normal operations. At 8:45 A.M. the receiving clerk noticed a sizable fire involving the racks in the wire storage section. The shipping office was reportedly notified immediately of the fire and the switchboard operator advised to telephone the alarm, but for some unexplained reason the fire department was not notified. Employees attempted to fight the fire with first aid extinguishers, but were soon driven from the building by the spreading flames.

Had the alarm been transmitted promptly by one of the employees it is possible that the fire would have been controlled. Several minutes elapsed after



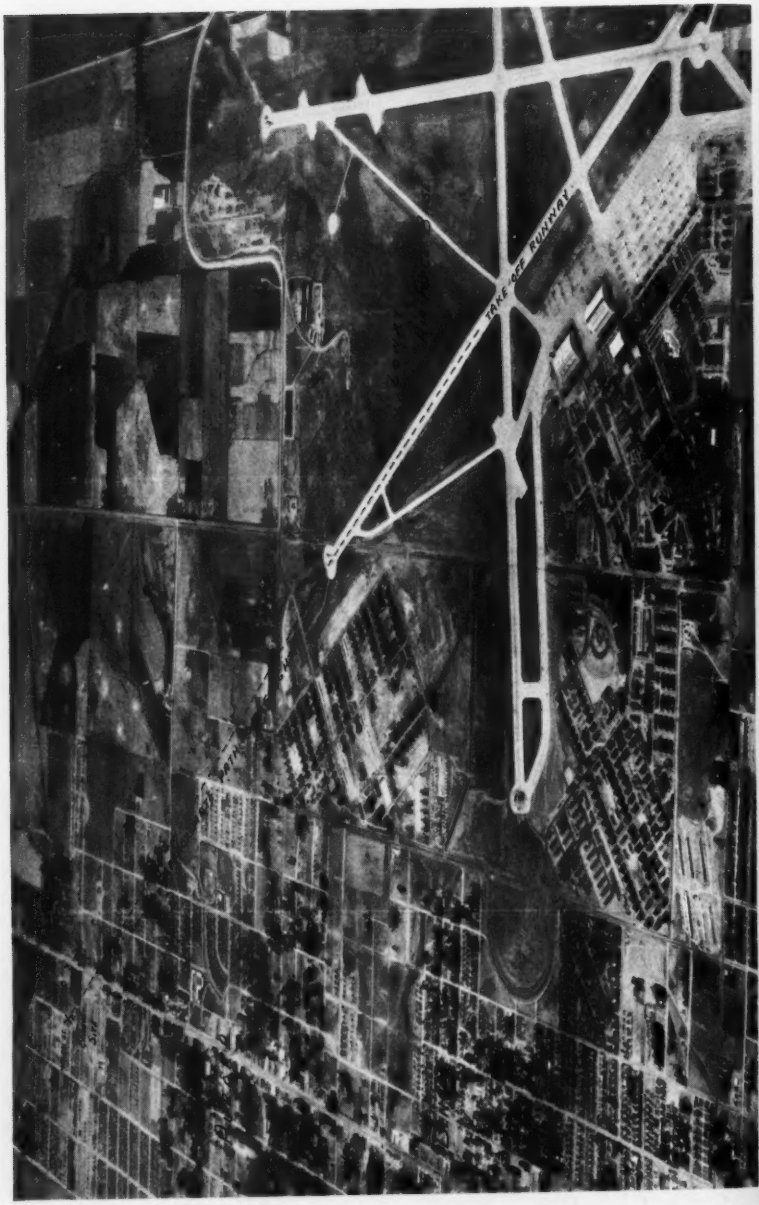
Wide World

This large electrical equipment warehouse at Portland, Oregon was destroyed by fire August 25. The building comprised a single fire area of 40,000 sq. ft., unsprinklered and loaded with electrical equipment in wooden crates or wrapped in paper or burlap. Failure of employees to send the alarm allowed the fire to spread beyond control before apparatus arrived.

employees had been driven from the building before the first apparatus arrived and by then flames had broken through the combustible roof. The alarm had been transmitted by an outsider three blocks from the fire who had seen smoke and flame issuing from the structure. An abortive attempt was made to fight the fire from within, but heat and smoke soon forced firemen from the building. Two additional alarms were struck within nine minutes of the first and twenty 2½-inch hose streams were soon in operation but had no appreciable effect on the fire, which continued out of control until 10:00 A.M. By then the roof had collapsed and all combustible contents had been consumed and wire and stored appliances had either melted or become distorted. Total estimated loss is $700,000 — $150,000 damage to building and $550,000 to contents.

Cause

Due to the extensive damage no evidence to indicate the probable cause could be unearthed. Although a battery-electric fork truck was parked in the area where the fire originated there was no plausible reason to attribute the start of this fire to this vehicle. The building wiring was in accordance with the National Electrical Code and the employee "no smoking" rule was strictly enforced. This fire is another instance therefore where the immediate cause could not be determined, although the factors responsible for the extensive damage could be readily discerned not only after the fire but before as well.



Aerial view of flight path taken by Jet plane before it crashed into a dwelling in Aurora, Colo., on May 14, 1950.

Coordinated Crash Fire Control*

U. S. Air Force Base Fire Departments are instructed to "enter into agreements with . . . municipal and/or local civilian . . . fire fighting organizations . . . in order to have available well-coordinated plans for . . . aircraft . . . rescue and fire fighting in off-station crashes."** The value of such coordination was particularly well illustrated in Aurora, Colorado, on May 14, 1950.

It was at approximately 1:55 P.M. on that Sunday afternoon that a USAF F-80 took off on a training flight from the Lowry Air Force Base in Denver. (The F-80 is a single engine jet fighter plane.) The approximate path of the aircraft's flight is illustrated in the aerial photo on the opposite page. It seemed apparent to ground observers, that the pilot knew he was in trouble. By the behavior and performance of the plane, it became quickly obvious that the pilot was heading for an open area just south of where he ultimately crashed. Experienced judgment indicated that he might have made it if he had jettisoned his wing-tip fuel tanks or if he had had sufficient altitude to clear a power line on the edge of the open area. He probably did not drop the tanks because of the congested dwelling area below.

The aircraft struck a power line pole just opposite a dwelling. After snapping off the pole, the aircraft struck the ground, bounced hard and became airborne, hit the ground again, snapping off a fire hydrant, exploded, bounced and cartwheeled into a one-story house at 1600 Macon St. and exploded again. The first explosion set fire to the surrounding ground as the jet (kerosene grade) fuel was scattered. The second explosion seemed to extinguish the original ground fire, but started other fires as flaming fuel was thrown a distance of 200 feet.

The result, fire-wise, was that besides 1600 Macon St., three other dwellings were involved (numbers 1608, 1616, and 1624) plus an automobile parked in front of 1601. These houses had asbestos sidings which the fire fighters found lessened the fire exposure hazard between the closely grouped homes. Those fires in the three exposed and involved homes fed principally on combustible trim and attic contents (flames entering the attics through open, attached garages).

The pilot was killed by the impact when the F-80 crashed into the dwelling. Two persons in near-by yards were burned by flaming jet fuel, neither too seriously. One was a girl playing in the garage at 1609; the other was a man in the yard at 1616.

Fire Alarm

The alarm for this crash was received by the Aurora Volunteer Fire Department, just *prior* to the actual impact. A gasoline station attendant with previous military experience determined from the attitude of the aircraft that a crash was imminent and estimated it would occur at 17th and Lima Streets, just one block north and one block west from the actual crash site. The impending crash was also noted by the Lowry Air Base control tower who sounded an alarm immediately.

Aurora fire equipment and crash units from the Air Base were thus on their way *prior* to the actual impact. Aurora apparatus, manned by 22 fire fighters, was at

Aerial view of flight path taken by Jet plane before it crashed into a dwelling in Aurora, Colo., on May 14, 1950.

*Based on Special Aircraft Accident Bulletin, Series 1950, No. 11 issued by the NFPA Committee on Aviation and Airport Fire Protection.

**Army-Navy Manual 00-80C-1 "Procedure for Aircraft Crash Rescue" (29 January 1947).

the scene at 1:59 (three minutes after the crash) and the Lowry trucks, manned by 25 fire fighters, reached the site after a longer travel distance at 2:02. The report to the NFPA states that traffic congestion and pedestrians around the site on this Sunday afternoon were a definite hindrance.

Fire Fighting

When the first unit arrived (a high-pressure "water fog" truck with a 400-gallon booster tank), garden hoses were being used by occupants and neighbors on 1608, 1616, and 1624 Macon St. The high-pressure unit went into operation at 1600, using water fog. The second fire rig on the scene was a combination pumper. A hose line was laid by firemen on this second truck on the way in from a Colfax Ave. hydrant (one block distant), requiring a 700 ft. lay of 2½-inch hose. (The sheared hydrant in front of 1600 Macon St. could not, of course, be used.) The intent was for the pumper to return to the Colfax Ave. hydrant to boost the pressure available but parked cars and sightseers barred the return route. Enough pressure was available, however, to reach the roof of the one-story dwelling at 1600 Macon St. and therefore the high-pressure fog truck moved down to 1608, 1616 and 1624 (in sequence) to secure speedy knock-down of the fires in these dwellings. Roofs were opened to gain access to the attic fires.

Lowry Air Base crash trucks arrived in the interval. A "Class 150" USAF crash truck (containing 3 tons of low-pressure carbon dioxide) moved in on the crash fire to lay a smothering blanket of CO_2. An Air Force's "Class 155" crash truck (having 1,000 gals of water with high-pressure pumps and foam equipment) then followed up with foam to blanket the fuel spillage. Two smaller USAF crash trucks were used to supply fog booster lines and to extinguish the Class A materials which were smoldering.

Immediately after the first Aurora fire truck reached the scene, one fireman was detailed to extinguish the burning automobile. This was quickly effected with dry chemical extinguishers.

The dwelling and car losses are estimated at $15,000. One dwelling (1600 Macon St., which the Jet crashed) was total; the others partial. The estimated value of the property involved was $28,000 (not including aircraft).

Prompt response of fire equipment, "combined agent" technique of fire fighting (see NFPA Standard No. 403-T), plus favorable structural conditions made it possible to hold fire losses to a minimum following a Jet plane crash into this dwelling in Aurora, Colo.

Fires and Fire Losses Classified, 1949

There were approximately 580,000 building fires in the United States in 1949 causing $672,500,000 damage, according to estimates compiled by the National Fire Protection Association. An additional 1,172,500 fires not involving buildings—aircraft, motor vehicles, forest, ship, rubbish, grass fires, etc.——accounted for an estimated $70,334,000 loss, and increased the number of fires of all types in the United States in 1949 to 1,752,500. The total loss was approximately $742,834,000. Building fire estimates for 1948 reported in the October 1949 *Quarterly,* showed 570,000 fires with loss of $714,800,000. It is interesting to note that the number of fires for 1949 has increased 2 per cent over 1948 figures, while the loss for 1949 is 5 per cent less than the previous year. Preliminary estimates by the National Board of Fire Underwriters for the first 8 months of 1950 indicate an increase of approximately 5 per cent over the same period of 1949.

The data from which Tables I to IV were compiled were obtained from nineteen state fire marshals' reports for the year 1949 or the closest fiscal year thereto. Reports of these particular states were chosen because they contained the most complete classification of cause and occupancy data. While the methods of reporting and tabulating fire loss figures differ from state to state, the volume of statistics from these nineteen typical states, representing all sections of the country, and including both primarily agricultural and industrial states, is sufficiently large to indicate the relative distribution of fires and fire losses. Table I shows the number of fires by occupancy in fifteen states and Table II the loss by occupancy in twelve states. Tables III and IV list the number of fires and loss by cause in seventeen and twelve states respectively. Table V summarizes loss statistics of all states that have furnished data to the NFPA. The fire experience for the state of Nebraska does not appear in Table I-IV. This omission is due to the fact that the state report was received after these tables were assembled.

Tables VI and VII, showing the nationwide distribution of fires and losses by occupancy and causes, are based primarily on typical state experience enumerated in Tables I to IV. Since the value of Table VI increases as the number of items reported is expanded, new classifications have been added from year to year whenever available data permitted. Although no new items could be included this year it is hoped that more detailed reporting of state experience will permit additional occupancies to be reported in the future. This year the only notable change appears in Table VI. The item previously listed as "Flour mills, elevators," now appears as "Grain mills, elevators" because of the general practice in state reports of reporting all grain handling and storage fires as a single item. Various sources have furnished figures for the individual items in Group VI. Statistics on aircraft fires were compiled by the NFPA Committee on Aviation and Airport Fire Protection. Motor vehicle data are based on a recent survey of 470 U. S. cities (Fire Record of Cities, April 1950 *Quarterly*). Forest fire estimates are those compiled and published by the Forest Service of the U. S. Department of Agriculture in its annual summary of forest fire statistics, which includes the number of forest fires by cause and size, the areas burned and the estimated damage. Results

Table I. Number of Fires by Occupancies in Fifteen States — 1949

Occupancies	Connecticut[1]	Illinois[2]	Indiana[3]	Iowa	Kansas	Louisiana	Minnesota	Montana[4]	New Hampshire	Ohio	Oklahoma	Oregon[4]	Texas	Vermont[4,5]	Wisconsin[4]	Total
I. PUBLIC BUILDINGS																
Government buildings	4	1	8	12	....	....	....	4	5	....	....	36	....	2	9	81
Hospitals, institutions	....	14	12	8	3	74	11	2	6	23	....	....	8	2	30	193
Schools and colleges	12	44	9	28	13	74	16	8	9	58	8	42	34	11	103	469
Churches	4	40	18	20	15	33	14	1	9	116	51	35	31	3	98	488
Theatres, including motion pictures	....	18	5	13	8	36	8	4	1	30	8	18	17	1	28	195
Amusements, halls	14	49	29	25	11	....	14	7	2	98	....	....	18	7	83	357
II. RESIDENTIAL																
Hotels	11	129*b*	27	35	46*e*	411*b,e*	104	33	14	222	231*l*	425*b,c*	95	13	125	1,921
Boarding and rooming houses	24	....	....	40	16	....	....	20	....	....	124	....	84	....	47	355
Apartments	89	274*c*	104	124	83	....	185*c*	16	16	1,330*c*	....	....	534	7	219	2,981
Dwellings	806	3,849	2,026	1,581	977	2,997	1,152	325	561	6,302	1,662	8,561*m*	3,043	550	17,099	51,491
III. MERCANTILE																
Offices and multiple mercantiles	19	92	21	36	29	314	30	9	....	125	115	622	99	1	57	1,569
Restaurants, taverns	52	234	86	110	58	....	60	20	20	....	....	189	208	13	600	1,650
Miscellaneous mercantiles	132	487	541	180	232	146	194	49	72	947	421	54	504	87	1,055	5,101
Warehouses	44	60	1	109	21	53	46	19	8	237	165	25	96	1	129	1,014
IV. MANUFACTURING																
Metal workers	5	17	16	17	20	4	....	3	13	....	....	46	....	6	64	211
Woodworkers	6	7	....	....	4	31	....	4	....	....	....	152	3	13	15	235
Grain mills, elevators	....	76	16	11	14	12	20	1	....	....	....	32	1	1	68	252
Packing plants	....	....	3	5	5	....	....	....	....	....	....	11	3	1	....	28
Bakeries	3	15	6	5	3	....	....	1	....	....	....	17	4	....	24	78
Textile workers	2	....	....	....	1	100*g*	....	....	....	....	....	4	29	1	3	140
Printing	3	....	3	7	4	....	1	1	....	....	....	5	5	....	24	53
Laundries	8	20	....	7	15	....	....	1	....	39	....	30*n*	27	3	18	168
Cleaners, tailors	7	17	22	13	....	....	12	1	4	37	320	....	41	1	35	510
Miscellaneous manufacturing	53	189	91	39	9	67	124	3	12	532	128	76	74	18	414	1,829
V. MISCELLANEOUS																
Barns	114	290	265	139	375*f*	144*f*	107	....	35	509	215	238*o*	406	280	844	3,961
Outbuildings	....	577	104	151	....	....	373	43	51	534	496	....	19	79	1,854	4,281
Lumber and coal yards	5	8	20	2	3	15	....	....	....	98	....	....	....	5	27	183
Piers, including shipyards	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2
Railroad property, inc. rolling stock	....	....	15	31	9	25*h*	....	2	....	....	....	....	....	....	146	228
Bulk oil storage, refineries	....	10	5	....	10	43*i*	....	....	....	....	....	40	....	....	....	108
Garages	110	530	249	221	21	32*j*	....	48	45	854*i*	284	43	51	12	407	2,907
Filling stations	16	61	21	31*d*	24	....	73*k*	2	9	....	96	....	37	9	59	438
Power plants, pump houses	....	5	39	13	5	....	7	6	....	....	....	36	....	1	90	202
Creameries and dairies	....	....	2	4	3	....	3	2	....	....	....	17	....	....	39	70
Miscellaneous structures	113*a*	417	33	145	6	118	216	4	52	3,629	2,330	10	97	49	51	7,270
Hangars and contents	....	1	....	....	2	....	2	1	....	....	....	....	....	....	4	10
VI. OTHER THAN BUILDING FIRES																
Aircraft	5	....	3	....	4	....	....	....	....	....	....	....	....	....	....	12
Motor vehicles	168	1,931	474	743	336	435	65	5	....	3,897	561	622	....	47	1,830	11,067
Watercraft	39	3	2	....	....	....	....	....	....	....	....	....	....	....	10	54
Forest fires	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Rubbish, grass, brush	....	24	....	23	4	....	....	....	....	....	962	....	....	....	70	1,083
Miscellaneous	....	206	253	163	....	....	....	....	....	104	....	....	....	....	610	1,336
Total	1,870	9,695	4,529	4,091	2,389	5,164	2,837	645	944	19,721	8,177	11,386	5,568	1,177	26,388	104,581

[1] Fiscal year ends June 30, 1949.
[2] Does not include Chicago.
[3] Fiscal year ends May 31, 1949.
[4] Insured claims only.
[5] No losses less than $50.

a. Includes buildings under construction.
b. Includes boarding houses.
c. Includes rooming houses.
d. Includes bulk oil storage.
e. Includes clubs.
f. Includes livestock, dwellings, hay, grain.
g. Includes laundries and cleaning.
h. Includes power plants, waterworks.
i. Includes filling stations.
j. Includes hangars.
k. Includes garages.
l. Includes restaurants.
m. Includes apartments.
n. Includes dry cleaning.
o. Includes outbuildings.

Total	1,870	9,695	4,529	4,091	2,389	5,164	2,837	645	944	19,721	8,177	11,386	5,568	1,177	26,388	104,581

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g. Includes laundries and cleaning.
h. Includes power plants, waterworks.
i. Includes filling stations.
j. Includes hangars.
k. Includes garages.
l. Includes restaurants.
m. Includes apartments.
n. Includes dry cleaning.
o. Includes outbuildings.

Table II. Fire Losses by Occupancies in Twelve States — 1949

Occupancies	Connecticut[1]	Illinois[2]	Indiana[3]	Iowa	Kansas	Louisiana	Minnesota	Ohio	Oregon[4]	Texas	Vermont[4,5]	Wisconsin[4]	Total
I. PUBLIC BUILDINGS													
Government buildings	$3,973	$50	$6,796	$436,156	.....	.....	$14,875	.....	$29,281	.....	$908	$1,409	$493,421
Hospitals, institutions	.....	396,409	14,346	63,625	$22,915	$53,407	48,785	$3,452	.....	$3,936	603	8,201	615,679
Schools and colleges	7,384	858,254	215,994	155,156	156,600	402,211	125,825	76,830	330,918	471,282	26,325	197,230	3,024,009
Churches	1,925	273,305	354,420	180,413	140,782	69,191	14,065	210,080	30,204	116,386	5,664	204,728	1,631,163
Theatres, including motion pictures	.....	109,516	175,470	71,401	30,581	173,626	71,170	413,590	44,865	51,227	150	164,064	1,305,660
Amusements, halls	60,815	340,542	111,060	212,321	61,807	.....	.....	227,259	.....	25,987	9,100	100,148	1,149,038
II. RESIDENTIAL													
Hotels	45,550	661,041*b*	6,053	21,956	350,210*e*	283,127*b,e*	23,335	50,199	272,792*b,c*	168,444	28,840	212,401	2,123,948
Boarding and rooming houses	29,268	.....	.....	20,989	49,349	.....	.....	.....	.....	81,048	.....	11,825	192,479
Apartments	92,180	300,007*c*	132,992	93,478	89,047	.....	139,075*c*	1,003,340*c*	.....	494,835	3,822	62,513	2,411,289
Dwellings	1,323,702	3,786,031	2,613,436	1,701,229	539,533	2,565,420	1,577,201	3,237,285	3,609,004*l*	2,781,242	368,365	4,298,022	28,400,4.0
III. MERCANTILE													
Offices and multiple mercantiles	35,981	211,107	71,415	48,561	78,375	584,340	40,626	285,669	1,172,945	275,193	172	20,747	2,825,131
Restaurants, taverns	188,744	512,660	166,788	180,916	43,165	.....	308,021	.....	253,045	634,603	97,658	417,004	2,802,604
Miscellaneous mercantiles	375,937	1,657,680	1,753,513	934,449	761,745	396,618	1,760,345	2,214,108	164,924	2,245,745	264,074	1,296,866	13,826,004
Warehouses	203,254	809,982	35	369,543	95,885	258,325	376,271	1,286,967	382,017	1,181,025	623	569,937	5,533,861
IV. MANUFACTURING													
Metal workers	5,349	292,825	37,830	55,862	54,431	26,135	.....	.....	229,173	.....	4,653	37,687	743,945
Woodworkers	2,273	9,185	.....	.....	1,345	68,080	.....	.....	1,634,150	9,100	102,071	8,261	1,834,465
Grain mills, elevators	.....	1,513,762	319,675	203,211	317,673	504,645	488,080	.....	989,651	20,000	390	97,450	4,454,737
Packing plants	.....	.....	10,880	427	26,753	.....	.....	.....	45,236	10,179	900	.....	100,375
Bakeries	6,910	2,925	2,000	9,850	4,805	.....	.....	.....	106,218	12,305	.....	27,780	172,793
Textile workers	2,000	.....	.....	.....	50	315,488*g*	.....	.....	592	182,432	13,811	2,254	516,627
Printing	5,048	.....	744	46,350	355	.....	170	.....	4,722	3,560	.....	10,188	71,137
Laundries	2,970	148,047	.....	14,041	22,588	.....	.....	162,425	32,163*m*	49,999	47,339	9,503	489,075
Cleaners, tailors	25,910	9,690	19,504	83,894	.....	.....	64,105	29,406	.....	62,036	267	10,143	304,955
Miscellaneous manufacturing	526,785	1,674,314	2,186,434	819,318	140,951	319,231	912,572	3,664,135	1,430,562	477,027	66,926	2,581,334	14,799,889
V. MISCELLANEOUS													
Barns	344,140	1,269,149	791,517	575,796	843,899*f*	387,685*f*	438,679	2,002,533	391,571*n*	.....	675,767	1,846,524	9,567,260
Outbuildings	.....	259,879	31,551	250,333	.....	.....	352,847	196,879	.....	178,460	63,277	390,503	1,723,729
Lumber and coal yards	3,400	115,910	226,178	182	16,590	70,963	.....	381,163	.....	52,223	139,066	158,745	1,164,420
Piers, including shipyards	10,100	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10,100
Railroad property, inc. rolling stock	.....	.....	51,345	151,642	1,795	83,643*h*	.....	.....	.....	.....	.....	43,731	332,156
Bulk oil storage, refineries	.....	26,300	17,391	.....	7,522	273,609*i*	.....	.....	81,622	.....	.....	.....	406,444
Garages	319,420	793,470	358,899	221,381	47,210	44,134*j*	.....	679,154*i*	55,759	61,191	18,262	216,454	2,815,334
Filling stations	6,373	42,085	35,782	55,442*d*	39,466	.....	523,469*k*	.....	.....	49,994	14,066	26,151	792,823
Power plants, pump houses	.....	15,625	27,802	163,440	5,393	.....	4,620	.....	96,449	.....	99	79,124	392,552
Creameries and dairies	.....	.....	11,300	2,790	1,375	.....	6,050	.....	29,254	.....	53,535	19,676	123,980
Miscellaneous structures	509,011*a*	529,090	118,093	118,361	2,407	450,352	624,712	4,189,913	74,031	527,464	25,829	40,216	7,183,660
Hangars and contents	.....	10,200	.....	.....	61,570	.....	10,440	.....	.....	.....	.....	6,329	88,539
VI. OTHER THAN BUILDING FIRES													
Aircraft	29,960	.....	4,250	.....	125,000	.....	.....	517,010	.....	.....	.....	241,377	805,097
Motor vehicles	73,411	351,607	103,030	196,425	45,938	60,878	201,156	.....	155,763	.....	.....	2,234	1,190,442
Watercraft	148,225	4,750	217	.....	.....	.....	.....	.....	.....	.....	.....	.....	153,192
Forest fires	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14,558	14,558
Rubbish, grass, brush	.....	4,560	.....	6,536	420	.....	.....	.....	.....	.....	.....	105,280	116,796
Miscellaneous	.....	227,844	105,864	60,018	.....	.....	.....	4,255	.....	.....	.....	.....	397,981
Total	$4,389,997	$17,217,801	$10,082,577	$7,525,492	$4,105,030	$7,391,118	$8,126,494	$20,835,652	$11,647,411	$10,232,923	$2,006,733	$13,540,597	$117,101,825

[1]Fiscal year ends June 30, 1949.
[2]Does not include Chicago.
[3]Fiscal year ends May 31, 1949.
[4]Insured claims only.
[5]No losses less than $50.

a. Includes buildings under construction.
b. Includes boarding houses.
c. Includes rooming houses.
d. Includes bulk oil storage.
e. Includes clubs.
f. Includes livestock, dwellings, hay, grain.
g. Includes laundries and cleaning.
h. Includes power plants, waterworks.
i. Includes filling stations.
j. Includes hangars.
k. Includes garages.
l. Includes apartments.
m. Includes dry cleaning.
n. Includes outbuildings.

Table III. Number of Fires by Causes in Seventeen States — 1949

Causes	Connecticut[1]	Illinois[2]	Indiana[3]	Iowa	Kansas	Kentucky[3]	Louisiana	Michigan	Montana[4]	New Hampshire	Ohio	Oklahoma	Oregon[4]	Rhode Island	Texas	Vermont[3,4]	Wisconsin[4]	Total
Chimneys, flues, defective or overheated	95	486	271	228	95	380	85	1,445	34	120	732	99	740	46	139	106	1,286	6,386
Sparks on roof	....	415	217	....	22	40	4	1,357	....	....	....	....	243	....	28	8	....	2,334
Defective or overheated heating equipment	164	641	280	237	129	489	552	4,493	75	106*b*	1,859	642	1,706	127	916	94	2,289	14,799
Rubbish	47	442	246	25	54	33	84	2,149	1	14	1,138	434	26	55	221	3	360	5,332
Combustibles near heaters	4*a*	....	....	6	....	....	....	....	1	....	....	....	....	....	....	14	323	348
Open lights, flames, sparks	47	220	18	317	46	40	127	222	4	....	1,209	. ..	177	3	14	....	1,242	3,686
Hot ashes, coals	12	127	235	49	118	62	46	281	5	....	147	....	736	7	....	30	172	2,027
Smoking and matches	257	1,118	559	472	222	458	794	3,796	82	162	3,811	332	2,859	145	954	149	4,801	20,971
Children and matches	71	....	....	86	....	....	....	1,050	22	27	606	160	....	....	150	....	325	2,497
Electrical, fixed service, fires due to misuse, or faulty wiring and equipment	197	2,158	318	228	337	435	655	1,990	44	80	3,968	167	1,181	97	666	91	2,002	14,614
Electrical, power consuming appliances	117	122	181	246	11	76	101	1,711	28	17	532	184	583*d*	....	155	14	1,510	5,588
Flammable liquids, misc. including home dry cleaning and starting fire with	33	882	37	55	164	46	222	364	9	9	1,040	303	225	11	358	124	75	3,957
Torches, welding, cutting, plumbers, etc.	30	....	46	59	....	....	....	....	8	12	128	....	....	....	....	....	124	407
Lamps, lanterns, oil stoves	80	....	164	177	....	....	....	458	8	140	....	132	....	22*f*	....	....	734	1,915
Gas and explosions	....	96	41	23	59	39	119	329	44	3	205	65	....	....	45	5	167	1,240
Grease, tar, etc.	18	140	36	62	26	86	122	....	16	12	244	....	871	19	156	20	813	2,641
Spontaneous ignition	43	204	79	107	31	28	28	2,450	4	24	334	208*c*	105	16	82	21	267	4,031
Lightning	49	179	84	79	75	393	340	340	15	25	304	11	46	6	91	72	7,584	9,693
Thawing pipes	5	....	5	17	....	....	....	96	5	3	....	....	....	....	11	....	16	158
Sparks from machinery, friction	....	33	25	28	8	43	63	....	1	....	....	....	87	43	26	6	70	433
Incendiary, suspicious	41	50	25	33	4	25	28	424	4	18	203	....	33	17	88	11	127	1,131
Miscellaneous	232	340	478	881	118	203	133	12,305	8	111	1,462	4,720	56	98	212	45	338	12,740
Unknown	246	1,394	969	506	708	1,160	1,341	3,406	175	48	1,434	720	1,274	242	788	285	1,030	15,726
Explosions	23	132	133	5	58	120	62	....	....	....	....	....	71*e*	....	84	2	427	1,117
Exposure	59	516	82	165	104	315	258	14,740	52	13	365	....	367	38	384	77	306	17,841
Totals	1,870	9,695	4,529	4,091	2,389	4,471	5,164	53,406	645	944	19,721	8,177	11,386	992	5,568	1,177	26,388	160,613

[1]Fiscal year ends June 30, 1949.
[2]Does not include Chicago.
[3]No losses less than $50.
[4]Insured losses only.
[5]Fiscal year ends May 31, 1949.
a. Includes cloths on light bulbs.
b. Includes oil hot water heaters.
c. Includes friction.
d. Includes hot metals.
e. Includes sparks from combustion.
f. Includes gas stoves.

[1]Fiscal year ends June 30, 1949.
[2]Does not include Chicago.
[3]No losses less than $50.
[4]Insured losses only.

[5]Fiscal year ends May 31, 1949.
a. Includes cloths on light bulbs.
b. Includes oil hot water heaters.
c. Includes friction.

e. Includes sparks from combustion.
f. Includes gas stoves.

Table IV. Fire Losses by Causes in Twelve States — 1949

Causes	Connecticut[2]	Illinois[3]	Indiana[3]	Iowa	Kansas	Kentucky[3]	Louisiana	Ohio	Oregon[4]	Texas	Vermont[3,4]	Wisconsin[4]	Total
Chimneys, flues, defective or overheated	$90,244	$853,261	$266,631	$297,500	$98,582	$524,348	$41,852	$749,753	$1,413,466	$69,640	$44,323	$492,080	$4,941,680
Sparks on roof	.....	235,299	164,326	.....	13,650	35,966	306	.....	173,258	15,988	11,256	.....	650,049
Defective or overheated heating equipment	224,657	663,202	342,112	551,110	88,373	727,153	490,194	1,676,370	704,500	1,161,045	109,955	1,303,086	8,041,757
Rubbish	25,651	178,522	143,371	10,004	9,094	21,459	78,477	273,460	6,338	140,835	643	221,446	1,109,300
Combustibles near heaters	6,113*a*	.....	.....	699	.....	.....	.....	.....	.....	.....	6,382	40,469	53,663
Open lights, flames, sparks	43,262	310,140	9,398	233,411	18,169	15,574	92,524	517,412	78,759	11,042	.....	1,015,364	2,345,035
Hot ashes, coals	17,715	81,948	295,845	79,280	48,704	24,589	36,160	86,622	298,478	.....	10,781	48,478	1,028,600
Smoking and matches	417,268	458,077	315,176	306,196	53,129	267,356	630,492	950,929	772,102	1,168,353	73,131	641,387	6,053,596
Children and matches	84,572	.....	.....	27,133	.....	.....	.....	231,139	.....	93,192	.....	103,980	540,016
Electrical, fixed service, fires due to misuse, or faulty wiring and equipment	410,226	2,352,589	1,871,862	561,654	209,785	901,293	1,051,010	2,130,302	1,384,958	1,255,161	160,376	2,673,497	14,962,713
Electrical, power consuming appliances	177,160	70,889	322,611	438,315	18,584	37,324	31,338	523,732	153,376*b*	156,381	11,577	389,575	2,330,862
Flammable liquids, misc. inc. home dry cleaning and starting fire with	184,609	1,340,222	33,339	129,843	227,940	57,143	417,091	572,329	294,519	450,943	98,545	30,892	3,837,415
Torches, welding, cutting, plumbers, etc.	40,591	.....	176,023	182,834	.....	.....	.....	188,209	.....	.....	.....	63,183	650,840
Lamps, lanterns, oil stoves	169,121	.....	89,677	191,959	.....	.....	.....	.....	.....	.....	.....	440,208	890,965
Gas and explosions	.....	64,646	27,110	436,677	54,450	40,528	107,581	299,850	.....	162,114	3,557	67,732	1,264,245
Grease, tar, etc.	16,008	36,301	19,874	37,253	18,818	43,233	46,186	188,430	277,088	89,349	3,524	217,008	943,072
Spontaneous ignition	103,164	482,757	508,090	220,974	44,442	153,803	97,849	413,572	403,990	492,668	21,499	790,848	3,733,656
Lightning	147,645	528,180	517,048	296,311	328,113	338,051	288,195	993,779	60,995	186,329	39,377	971,029	4,695,052
Thawing pipes	3,932	.....	1,755	2,368	.....	.....	.....	.....	.....	6,492	.....	8,654	23,201
Sparks from machinery, friction	.....	135,949	75,186	25,087	3,531	57,861	80,247	.....	211,267	44,419	3,141	154,369	791,057
Incendiary, suspicious	116,061	51,345	56,416	66,045	42,319	52,541	88,806	562,697	53,104	475,761	30,887	885,739	2,481,721
Miscellaneous	582,358	185,248	433,227	502,445	69,355	150,408	117,491	1,075,826	45,190	528,218	50,348	253,405	3,993,519
Unknown	1,320,227	7,789,649	3,903,970	2,445,569	2,434,791	3,876,834	3,248,934	9,077,150	4,714,252	2,962,371	1,182,705	2,248,996	45,205,448
Explosions	64,300	501,770	435,081	183,060	142,962	108,424	152,693	.....	55,609*c*	86,807	8,314	280,093	2,019,113
Exposure	145,113	897,807	74,449	299,765	180,239	274,491	293,692	324,091	596,162	675,835	136,412	199,079	4,097,135
Totals	$4,389,997	$17,217,801	$10,082,577	$7,525,492	$4,105,030	$7,708,379	$7,391,118	$20,835,652	$11,647,411	$10,232,923	$2,006,733	$13,540,597	$116,683,710

[1]Fiscal year ends June 30, 1949.
[2]Does not include Chicago.
[3]No losses less than $50.
[4]Insured losses only.
[5]Fiscal year ends May 31, 1949.
a. Includes cloths on light bulbs.
b. Includes hot metals.
c. Includes sparks from combustion.

of a recent survey of U. S. cities were also the basis for an estimate of the number of rubbish, grass and brush fires. The 1949 estimates of 755,000 represent a 2 per cent increase over 1948.

As will be seen in Table V, the nineteen states with a population of 56,519,000 reported a total of 165,693 fires. Experience indicates that this is somewhat under half the actual number of fires. Many states, for example, do not report fires with losses of less than $25 to $50. To obtain a more nearly accurate estimate of the number of fires in these nineteen states, therefore, 100 per cent is added. Making use of this figure and the population ratio, the number of building fires for the nation has been calculated.

To obtain the estimated national fire loss, the population ratio was applied to the loss of the reporting states. To account for losses not reported through the usual channels, 33 1/3 per cent was added as in the previous years. Further adjustment was necessary in a few instances because of unusually large property damage in individual fires.

Table V. Fires per 1000 Population and Fire Loss per Person for Nineteen States, 1949, as Reported by Fire Marshals

State	Population (Estimated)	No. of Fires	Fires per 1000 Pop.	Fire Loss	Fire Loss Per Person
Connecticut[1]	1,995,000	1,870	.94	$4,389,997	$2.20
Illinois [2]	4,849,000	9,695	2.00	17,217,801	3.56
Indiana[3]	3,921,000	4,529	1.15	10,082,577	2.56
Iowa[6]	2,613,000	4,091	1.57	7,525,492	2.88
Kansas	1,947,000	2,389	1.23	4,105,030	2.12
Kentucky[4]	2,922,000	4,471	1.53	7,708,379	2.64
Louisiana	2,667,000	5,164	1.94	7,391,118	2.77
Michigan	6,309,000	53,406	8.45	25,162,958	3.98
Minnesota[6]	2,977,000	2,837	.95	8,126,494	2.74
Montana[5,6]	587,000	645	1.10	1,734,578	2.96
Nebraska	1,318,000	2,243	1.71	4,352,432	3.31
New Hampshire[6]	530,000	944	1.78	3,019,913	5.69
Ohio	7,899,000	19,721	2.50	20,835,652	2.64
Oklahoma[6]	2,224,000	8,177	3.68	818,015	.37
Oregon[4,5,6]	1,512,000	11,386	7.50	11,647,411	7.70
Rhode Island	780,000	992	1.27	2,501,614	3.20
Texas	7,672,000	5,568	1.38	10,232,923	1.32
Vermont[4,5]	376,000	1,177	3.12	2,006,733	5.34
Wisconsin[5,6]	3,421,000	26,388	7.70	13,540,597	3.95
Totals	56,519,000	165,693	2.92	$161,399,714	$2.85

[1]Fiscal year ends June 30, 1949.
[2]Chicago losses and population not included.
[3]Fiscal year ends May 31, 1949.
[4]No losses less than $50.
[5]Insured claims only.
[6]Building and contents losses only.

States Reporting Partial Data (Not Included in Tabulations)

State	Population	No. of Fires	Fire Loss	Fire Loss Per Person
Colorado[1]	1,318,000	....	$7,144,986	$5.42
Delaware[1]	317,000	....	2,262,042	7.14
Nevada[1]	158,000	....	1,569,635	9.93
New Jersey[1]	4,839,000	....	17,887,377	3.70
New York	14,392,000	....	52,569,002	3.66
Tennessee	3,282,000	....	8,516,072	2.60
Utah[1]	687,000	....	2,410,715	3.51

[1]Insured losses only.

Table VI. Estimated Distribution of U. S. Fire Losses by Occupancies, 1949

These estimated figures are intended to show the relative order of magnitude of fire losses by occupancies, and while they are reasonable approximations based on the experience in typical states, they should not be taken as exact records for each class.

	No. of Fires	Losses
I. PUBLIC BUILDINGS		
Government buildings	1,200	$2,000,000
Hospitals, institutions	1,400	2,000,000
Schools and colleges	3,100	14,000,000
Churches	3,200	9,000,000
Theatres, including motion pictures	1,300	5,000,000
Amusement, halls	2,800	6,500,000
II. RESIDENTIAL		
Hotels	10,000	4,100,000
Boarding and rooming houses	13,200	8,800,000
Apartments	48,000	15,000,000
Dwellings	282,000	176,000,000
III. MERCANTILE		
Offices and multiple mercantiles	10,500	17,000,000
Restaurants, taverns	15,300	27,800,000
Miscellaneous mercantiles	33,800	66,000,000
Warehouses	6,700	32,000,000
IV. MANUFACTURING		
Metal workers	2,500	12,500,000
Woodworkers	2,000	15,100,000
Grain mills, elevators	2,300	26,000,000
Packing plants	900	6,000,000
Bakeries	800	1,200,000
Textile workers	4,400	6,000,000
Printing	600	1,000,000
Laundries	1,500	3,000,000
Cleaners, tailors	3,000	3,000,000
Miscellaneous manufacturing	12,100	60,000,000
V. MISCELLANEOUS		
Barns	23,600	40,000,000
Outbuildings	33,000	10,200,000
Lumber and coal yards	1,900	10,000,000
Piers, including shipyards	1,500	9,000,000
Railroad property, inc. rolling stock	4,900	7,850,000
Bulk oil storage, refineries	1,800	13,100,000
Garages	21,000	20,000,000
Filling stations	4,000	3,300,000
Power plants, pump houses	1,400	6,250,000
Creameries and dairies	1,000	2,600,000
Miscellaneous structures	23,200	23,200,000
Hangars and contents	100	8,000,000
TOTAL (BUILDING FIRES)	580,000	$672,500,000
VI. OTHER THAN BUILDING FIRES		
Aircraft	250	13,000,000
Motor vehicles	206,000	9,850,000
Forest fires	193,750	43,484,000
Rubbish, grass, brush	755,000	.....
Miscellaneous	17,500	4,000,000
TOTAL (OTHER THAN BUILDING FIRES)	1,172,500	$70,334,000
GRAND TOTAL	1,752,500	$742,834,000

NOTE: As explained in the text, 100 per cent has been added in estimating the number of fires, and 33⅓ per cent has been added to the losses to cover unreported losses.

Railroad losses have been separated from pier and wharf property fire losses reported by State Fire Marshals. Railroad losses from Association of American Railroads report.

Table VII. Estimated Distribution of U. S. Building Fire Losses by Causes, 1949

These estimated figures are intended to show the relative order of magnitude of fire losses by occupancies, and while they are reasonable approximations based on the experience in typical states, they should not be taken as exact records for each class.

	No. of Fires	Losses
Chimneys, flues—defective or overheated	30,000	$23,400,000
Sparks on roof	21,800	15,000,000
Defective or overheated heating equipment	54,500	60,000,000
Rubbish	30,000	6,000,000
Combustibles near heaters	8,000	8,000,000
Open lights, flames, sparks	23,000	15,000,000
Hot ashes, coals	10,000	12,200,000
Smoking and matches	95,000	55,500,000
Children and matches	22,600	8,000,000
Electrical, fixed services, fires due to misuse, or faulty wiring and equipment	54,000	71,500,000
Electrical power consuming appliances	21,000	11,000,000
Flammable liquids, misc., including home dry cleaning and starting fires with	17,000	25,000,000
Torches, welding, cutting, plumbers, etc.	5,500	7,000,000
Lamps, lanterns, oil stoves	25,000	25,000,000
Gas and appliances	5,000	6,800,000
Grease, tar, etc.	11,000	7,000,000
Spontaneous ignition	10,800	21,000,000
Lightning	26,700	25,000,000
Thawing pipes	1,500	2,100,000
Sparks from machinery, friction	2,500	7,000,000
Incendiary, suspicious	6,600	12,500,000
Miscellaneous	36,500	14,500,000
Unknown	44,500	197,200,000
Explosions	7,500	17,200,000
Exposure	10,000	19,600,000
TOTAL	580,000	$672,500,000

Air Conditioning Fires

Air conditioning has "come of age." During the past twenty-five years this luxury of modern living has developed from a "20 degrees cooler inside" curiosity to a commonly accepted device for healthful comfort. It is estimated that there are today in the United States and Canada alone more than 200,000 air conditioning systems. One American city noted for its excessive heat has recently claimed with Chamber of Commerce pride that now, due to the almost universal use of conditioned air in its buildings, it is one of the most comfortable cities on the American continent to live and work.

In air conditioning systems there are certain inherent hazards that can adversely affect the degree of fire safety of a building. These hazards have been recognized by those concerned with protection of life and property from fire since the earliest air conditioning system installations and were first covered in NFPA standards dated 1900. The NFPA standards in their present form date from 1936 when the NFPA Committee on Air Conditioning was organized to take over this subject from the old Committee on Blower and Exhaust Systems. Since then the Committee's original recommendations have been kept up to date by amendments dictated by experience and new developments, and thereby maintain their reputation as the recognized guide for safe installations.

The NFPA Standards for the Installation of Air Conditioning, Warm Air Heating, Air Cooling and Ventilating Systems (NFPA Standard No. 90; also adopted and published by the National Board of Fire Underwriters) are easy to understand and contain practical and fundamentally sound recommendations. It is not coincidence that of the 53 typical fires involving air conditioning systems chosen at random for this fire record, all but one installation departed from the Standard in at least one feature and in more than one in several instances. The one exception was a fire in which the loss was $25.

NFPA Standard No. 90 applies to air duct systems employing mechanical means for the movement of air and used for heating and ventilating, including warm air heating systems, plain ventilating systems, air cooling systems, air conditioning systems and exhaust systems. The Standards do not apply to systems for removal of flammable vapors and residues nor to systems conveying dust, stock or refuse by means of air currents. Part I applies to systems in other than residences, Part II to systems in residences. The air conditioning systems in this fire record were installed in other than residences.

As is true in most serious fires, violations of fundamental principles of fire safety not related to the air conditioning system — open stairways, poor housekeeping, lack of automatic protection, etc. —were noted in many of the fires cited in this record. These factors have been mentioned in the individual reports and emphasize that in addition to the substandard features of the air conditioning system other violations of fire safe construction and protection have influenced the extent of damage.

In order to emphasize the principal substandard features of the air conditioning systems involved in these fires a new

method of approach has been adopted in this fire record. It will be noted that certain of the principal provisions of the Standard have been quoted, each followed by one or more case histories in which failure to follow that particular provision played an important part in the extent of loss or increased the threat to life safety.

Acme

Air conditioning equipment was severely damaged when fire broke out on the second floor congested stockroom in which the air conditioning equipment was housed. The fire occurred January 15, 1950, at Dallas, Texas. **(See page 149.)**

In many air conditioning systems more than one substandard condition was noted. In those instances section numbers of the other pertinent parts of the Standard will be found at the end of the report.

It is hoped that this method of approach will make the fire record a useful tool for fire protection engineers attempting to overcome resistance to compliance with specific provisions of the Standard.

Construction of Ducts

Ducts shall be constructed entirely of noncombustible material, such as iron, steel, aluminum, or other approved material. **NFPA Standard No. 90, Sec. 3.**

RESTAURANT, BERKLEY, MICHIGAN, OCT. 1, 1944.

An employee and the watchman in this one-story and attic masonry walled, wood-roofed building attempted to fight a fire in the cocktail bar with first aid extinguishers. When their efforts failed, the employee left by the rear exit and the watchman by the front door. However, for some unknown reason the watchman failed to reach the exit and lost his life in the flames. Fire spread from the bar through the ceiling to the attic, where it entered combustible air conditioning ducts and spread to the dining room and other parts of the building. The alarm was finally transmitted when police, two blocks away, saw flames coming from the front of the building. Loss was $57,000.

THEATRE, WILMAR, CALIFORNIA, MAY 22, 1949.

An arson fire that was set in three places on the first floor of this one-story masonry, wood-joisted motion picture theatre entered air conditioning duct openings and spread through the combustible duct that ran the full length of the attic. After burning through the duct, fire inflicted severe damage to the roof structure before it was extinguished by firemen using fog nozzles directed through roof ventilators. Loss was $37,500.

FRUIT COLD STORAGE, MEDFORD, OREGON, JUNE 22, 1949.

Ignition of cork insulation in a basement cold storage room by welding sparks was the cause of fire that destroyed the unsprinklered 3-story masonry and heavy timber section and inflicted extensive damage on the two upper floors of an adjoining fire-resistive section. Flames entered the wooden cold air distributing duct suspended from the basement ceiling, traveled laterally to the main vertical duct (also wooden) and then vertically through the duct to the third floor where it broke into the open and mushroomed. Flames spread to the adjoining fire-resistive section through a duct that pierced the intervening fire wall. No automatic dampers were installed at the junction of branch ducts with the main duct nor were there fire doors installed in the duct where it passed through the fire wall. Loss $235,000. (See also NFPA Standard No. 90, Secs. 131 and 135 (a).)

Flexible woven asbestos or other approved fire-resistive material, or sleeve joints with rope asbestos packing or other approved noncombustible material shall be provided where flexible connections to prevent transmission of vibrations through the duct system are desired. This requirement does not apply to the joint connecting fans, where the intake or discharge of the fan is in the same room or enclosure as the joint. **NFPA Standard No. 90, Sec. 113.**

DEPARTMENT STORE, DALLAS, TEXAS, JAN. 14, 1950.

Fire broke out in the congested department store storeroom on the second floor of the 8-story fire-resistive building. The equipment for the conduit-type air conditioning system that served offices on the third through eighth floors was located on this floor. The outside air for the system was brought down through the third floor, across the ceiling of the second floor storeroom and vented into the air conditioning apparatus. The conduit headers for the entire system were at the ceiling of the second floor storeroom. This floor was completely gutted by fire and the lead anchor shields used for supporting the conduit were melted out and conduit was distorted and sagged, thereby opening large gaps in the conduit. However, there was no evidence that smoke and fire had been carried through the eight-inch risers to the floors above. The system was shut down within a few minutes of the start of the fire.

Another air conditioning system of the conventional type was located on the second floor and served the first floor department store. Horizontal ducts ran on the ceiling of the second floor from which vertical drops from the

horizontal duct work carried air to outlets on the first floor ceiling. The flexible canvas connections of the system burned out quickly, allowing air from the blowers to fan flames into wooden stock shelving filled with combustible merchandise. The building was sprinklered but the sprinkler system was undergoing alterations and was not in service at the time of the fire. Due to the heat and congested smoke, firemen experienced considerable difficulty in controlling the blaze and required three hours for complete extinguishment. Loss $590,000. (See also NFPA Standard No. 90, Sec. 113.)

Combustible coverings or combustible exterior insulations to ducts are not recommended and should not be used generally, particularly in concealed locations of non-fire-resistive construction, unless covered with a cement or gypsum plaster coating of ¼-inch thickness. On ducts with entering air temperatures exceeding 175°F. combustible coverings shall not be used. **NFPA Standard No. 90, Sec. 114 (b).**

HOTEL, CINCINNATI, OHIO, JAN. 21, 1942.

Fire in the air-conditioning room on the top floor of the 5-story section of this 5 to 48-story fire-resistive building was extinguished with little spread from the immediate area of origin, but smoke and water caused extensive damage to the building and its contents. Among the notable substandard conditions in the installation were a combustible covering of two layers of cork covered with pitch mastic on the ducts and units, location of control switches in the air-conditioning room where they could not be reached when fire and smoke filled the area, and absence of automatic dampers in the ducts.

Ignition of the cork insulation from sparks by an acetylene torch operation in a communicating room was the probable cause of fire discovered by employees without appreciable delay at 2:00 P.M. Burning insulation was already giving off such dense smoke that entry could not be made into the air conditioning room to fight the fire at close quarters or to shut off control switches. Standpipe lines were directed through doorways and holes which had been knocked in the walls and roof, and the equipment was eventually shut down by pulling the main switch in the sub-basement. Fire continued out of control until 4:00 P.M., when smoke had cleared sufficiently to allow firemen to enter. Prior to this time smoke had poured from the air-conditioning room to many parts of the building through air ducts and windows. Water damage was necessarily heavy due to the difficulty in getting water on the fire. Had sprinklers been installed in the air-conditioning room, as they were in certain other areas of the hotel, the fire could undoubtedly have been controlled with a minimum of smoke and water damage instead of the $559,500 damage actually caused. (See also NFPA Standard No. 90, Secs. 135 (a), 171 and 201.)

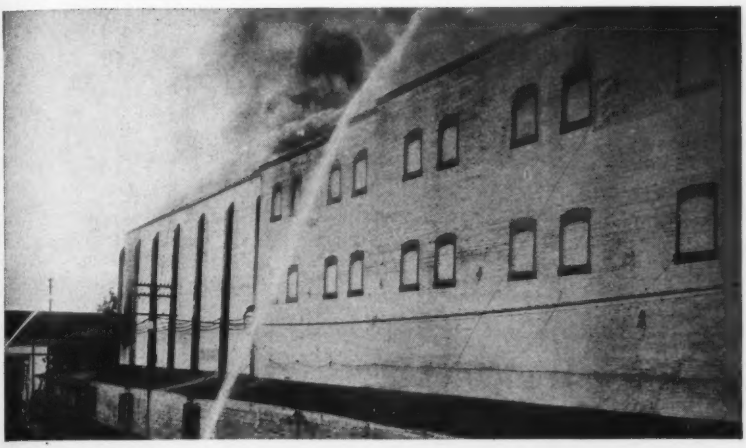
Installation of Ducts

In no case shall the clearance from metal ducts to stored combustible material be less than six inches, and to combustible construction, including plaster on wood lath, it shall not be less than ½ inch. **NFPA Standard No. 90, Sec. 121.**

BOWLING ALLEYS, CHICAGO, ILL., JAN. 4, 1945.

A porter discovered smoke coming from the exhaust ducts near the air conditioning equipment in the bowling alley and gave the alarm at 5:52 A.M. Fire of unknown origin destroyed this large establishment containing restaurant and bar faciliites. Except for a stove in the pin boys' room, the building was unheated at the time fire was discovered. Formerly a garage, the building had brick walls, one-inch boards on wood truss roof, with a ground area of 30,000 square feet. A suspended wire lath and plaster ceiling formed a concealed attic space without draft stops or automatic alarm or sprinkler protection which contained the air conditioning fan unit and metal ducts. When heated the metal ducts, supported by the lower chord of the wood trusses, helped to spread the fire throughout the large open unprotected attic space. Improper arrangement of pin storage and refinishing, as well as storage of a large supply of shellac, lacquer and thinner in ordinary five-gallon cans and fifty-gallon drums, was apparently not the direct cause of the fire. Loss $250,000.

No attic, basement or concealed space in a building shall be used as an integral part of a duct system unless it conforms to all the requirements for ducts. Such arrangement shall be subject to the approval of the inspection department having jurisdiction. Plenum chambers which conform to all the requirements for ducts may be located in any such portion of the building; such chambers shall not be used for storage or occupational purposes. **NFPA Standard No. 90, Sec. 125 (a).**



Oregon State Fire Marshal

Combustible air ducts offer a ready means for fire spread. Fire in this cold storage plant at Medford, Ore., June 22, 1949, originated in the basement, spread through a combustible air conditioning duct to the upper floors, and then burned down through the structure. Absence of fire doors in the duct where it passed through a fire wall permitted flames to spread to the adjoining fire-resistive section. **(See page 149.)**

Only fire-resistive linings acceptable to the inspection department having jurisdiction shall be used inside of ducts. **NFPA Standard No. 90, Sec. 114 (a).**

CLOTHING STORE, LOS ANGELES, CALIF. JAN. 27, 1939.

A short circuit in the fan motor in the air conditioning unit on the third floor caused fire that melted the joints in the cooling coils and allowed freon to escape into the ducts. Employees reported the fire at 2:24 P.M. when smoke and refrigerant issued from the air ducts into sales areas of the sprinklered 7-story masonry, wood-joisted building. Fire damage was confined to the metal, fibreboard-lined plenum chamber and the floor beneath the motor. Smoke caused considerable damage to stocks of suits on the second floor. In addition to substandard plenum chamber construction and protection, installation did not comply with cooling coil construction requirements in the Safety Code for Mechanical Refrigeration. Recommendations for the installation of sprinkler heads in the plenum chamber had been ignored by the management.

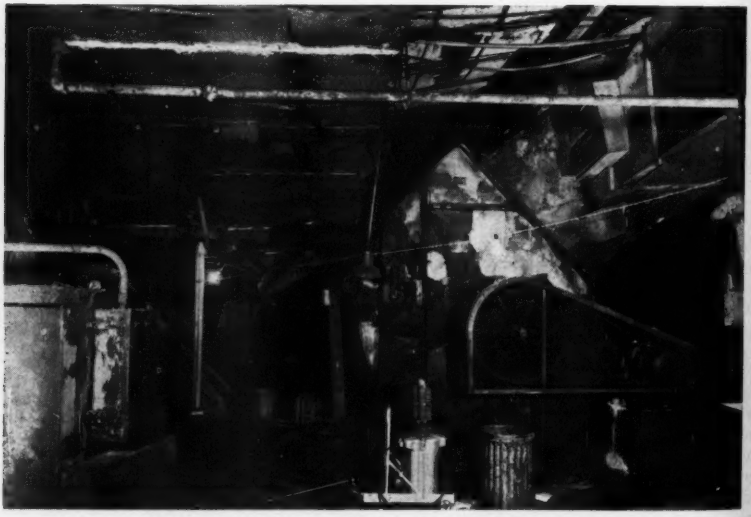
SCHOOL, PLEASANTVILLE, IOWA, FEB. 1, 1940.

At 5:00 A.M. a neighbor saw a light in the basement of the school and when it persisted, decided the building was on fire and called the fire department. Responding firemen discovered fire in the ceiling of the basement room housing the ventilating fan, janitor's supplies and a machine shop. The ceiling was pulled down and the fire was at one time considered under control. However, when flames ate through the floor into the room above, they immediately communicated to the large undivided attic of the 2-story brick, wood-joisted building through ventilation ducts that terminated in the combustible attic. From then until the building was destroyed, the fire was beyond the control of the poorly equipped fire department. Loss, $64,300.

BOWLING ALLEY, JOLIET, ILL., MARCH 2, 1947.

A combination club house and bowling alley located outside the city limits was destroyed by fire that originated in the combustible fibreboard plenum chamber located in the attic space formed by a combustible fibreboard ceiling suspended above the bowling alleys. The plenum chamber housed a steel cabinet containing approved glass filters, steam coils and a blower fan powered by an electric motor. Fire is believed to have been caused by a short-circuit of the blower fan motor. Two janitors discovered smoke coming from the bowling alleys and after locating the fire attempted to fight it with hand extinguishers for ten minutes before calling the fire department at 7:00 A.M. Upon arrival, firemen found the 1- and 2-story masonry, wood-joisted building totally involved

Holes had to be drilled in the roof of this hotel to direct hose streams on burning combustible duct coverings. The fire occurred January 21, 1942, at Cincinnati, Ohio. (See page 150.)



Air conditioning room of Cincinnati hotel, where fire occurred January 21, 1942.

and directed their efforts toward saving the neighboring caretaker's home with the meager water supply that was available. Loss was $77,500.

DRUG MANUFACTURING, MORRIS PLAINS, N. J., MAY 17, 1950.

While brazing a steam pipe in the air intake to the 60,000 cubic feet per minute blower (shut down during repairs) the welder fell from a step-ladder, allowing his acetylene torch to come in contact with the bank of 78 recently installed steel-wool filter mats. Four sprinklers in the fan room opened promptly and extinguished the burning oil coating and cardboard binding of the filters but water flowing around pipes and through a floor grating damaged a large amount of advertising material stored on the first floor. There was also considerable damage to 200,000 I.B.M. cards stored in the fan room. Loss, $4,200. (See also NFPA Standard No. 90, Sec. 151(b).)

Dampers

Where duct systems serve two or more floors, approved fire dampers shall be required at each direct outlet or inlet and in each branch duct at its junction with the main vertical duct. Dampers are not required at room openings in the branch duct. **NFPA Standard No. 90, Sec. 135 (a).**

SCHOOL, EAST LANSDOWNE, PA., FEB. 2, 1940.

The 3-story building was aflame from basement to roof when fire was discovered by a milkman at 4:42 A.M. The fire originated in the basement near the hot air blower and spread through air ducts to each room of the building. Ducts were not equipped with automatic dampers. Loss, $48,000.

THEATRE AND APARTMENTS, MIDLAND, MICH., APR. 19, 1943.

After burning rubbish behind the building the janitor decided to start the air conditioning system to clear the theatre of smoke which he assumed had come from the rubbish fire. He then went to the cafeteria on the first floor to eat his lunch. The smoke was actually coming from a fire in the basement ignited by embers from the fire outdoors that had entered through an open window not a part of the system. When the blaze was finally discovered the entire basement was involved, and flames had spread through the air conditioning duct to the attic. Fire was issuing from the basement and attic and smoke was coming from all windows of the multi-story brick, wood-joisted building when apparatus arrived. Loss was $105,000.

NIGHT CLUB, HOLLYWOOD, CALIF., JUNE 27, 1943.

At 3:57 A.M. a watchman in an adjoining building heard glass breaking in the one- and two-story night club and upon discovering fire telephoned the fire department immediately. The fire is reported to have originated in an upholstered wall bench in the cocktail lounge possibly from a carelessly discarded cigarette and was beyond control when discovered. The air conditioning system, without dampers, which had been left in operation during the night, is reported to have been a major factor in the extensive damage since fire spread through the ducts to the attic. Loss was $63,500. (See also NFPA Standard No. 90, Sec. 172.)

FUR COLD STORAGE, NEW HAVEN, CONN., SEPT. 24, 1943.

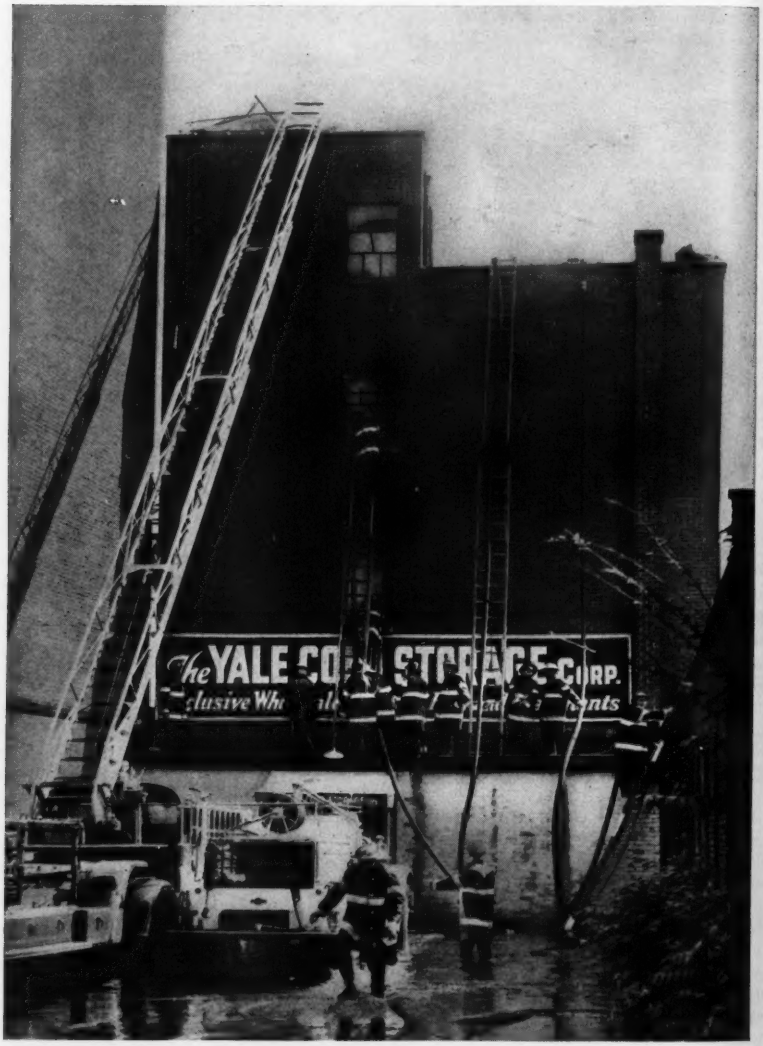
An extension light bulb in contact with a fur coat is the reported cause of fire that originated on the first floor of the 3-story fire-resistive building and spread through air conditioning ducts without dampers to the two floors above and to the basement. When firemen were unable to gain entrance to the building through a vault type door in the solid wall structure, holes were cut through the walls and roof to permit the use of hose streams. Grille openings between floors, congested storage, lack of automatic dampers in the air conditioning ducts and failure to equip air circulating fans with heat-actuated automatic shut offs were factors permitting fire spread and hampering firemen. Loss was $3,000,000. (See also NFPA Standard No. 90, Sec. 201.)

FIVE AND TEN CENT STORE, SPARTANBURG, S. C., JAN. 17, 1945.

Fire that originated in the basement of this two-story masonry, wood-joisted building was discovered by an employee of a cafe across the street at 5:38 A.M. Due to the intense smoke, firemen were unable to enter the basement to control the fast spreading fire before it entered air conditioning ducts lacking dampers and spread through them to the attic. Loss was $241,000.

RESTAURANT, ROCHESTER, N. Y., MAR. 2, 1946.

On discovery of fire at the electric panel board located in the air conditioning room in the basement, the janitor attacked the flames with a foam extinguisher with apparent success and did not call the fire department. Twenty



Acme

An estimated $3,000,000 damage was caused to fur garments closely packed on all floors of this 3-story fire-resistive building in New Haven, Conn., September 24, 1943. Grille openings beween floors, lack of automatic dampers in the air conditioning ducts and failure to equip air circulating fans with heat actuated automatic shut-offs were some of the factors permitting fire spread and hampering fire fighting. **(See page 153.)**

minutes later the fire was again discovered and this time the fire department was notified by the janitor, who pulled a street box several blocks away, although one was located 300 feet from the fire. Further delay was encountered when a high pressure steam line broke in the air conditioning room and kept firemen from entering. In the meantime fire had spread through the air conditioning duct, which lacked dampers, to the first floor of the brick, wood-joisted building. Loss, $50,000.

BEARING MANUFACTURE, CLARK TOWNSHIP, N. J., AUG. 21, 1948.

Ignition of oil accumulation on a run-in machine by defective electrical equipment was the probable cause of fire that broke out at 11:50 A.M. in the first floor testing and packaging department of this unsprinklered two-story fire-resistive building. Employees attempted to extinguish the fire with first aid extinguishers, but the blaze spread rapidly beyond control along the acoustical fibreboard material on the ceiling and was intensified as flaming squares dropped to the floor. Firemen responded to an alarm at 12:05 P.M. and were able to confine the fire to the 13,000 sq. ft. area of origin. However, the inspection department on the first floor, and the cafeteria, conference room and record rooms on the second floor suffered extensive damage from smoke which passed to these areas through damperless air conditioning ducts before the system was manually shut down. No heat or smoke actuated devices were installed in the ducts to prevent the spread of fire or smoke. Loss was $250,000. (See also NFPA Standard No. 90, Sec. 201.)

Fresh air intakes shall be protected with approved automatic fire doors or dampers except where permission to omit them, because of light exposure, is granted by the inspection department having jurisdiction. When deemed necessary by inspection department, approved heat actuated devices shall be installed at intake openings to shut fans down in case of exposure fires. **NFPA Standard No. 90, Sec. 136.**

THEATRE, STROUDSBURG, PA., APRIL 14, 1942.

The 3-story brick, wood-joisted building housing a theatre, stores and apartments was destroyed by fire that originated outside the building in an automobile storage shed in the rear. Flames spread into the theatre auditorium through an exterior wall opening of the air conditioning system. Loss, $57,000. (See also NFPA Standard No. 90, Sec. 144.)

GROUP FIRE, WILMINGTON, N. C., JAN. 21, 1949.

Two hotel guests were killed and three buildings housing a hotel, several shops and a theatre were destroyed by fire that originated in a store on the first floor of the hotel building shortly after midnight. Flames spread to the theatre building through an exposed opening of the air conditioning system on the theatre roof. Total loss $512,000.

Air Intakes and Outlets

Discharge and exhaust air openings and recirculating air intakes shall be located at least 3 inches above the floor, except that protected floor inlets may be permitted, under seats, in theatres. When located less than 7 feet above the floor, inlet and outlet openings shall be protected by a substantial grille or screen, through the openings in which a half-inch sphere will not pass. **NFPA Standard No. 90, Sec. 142.**

AIRCRAFT MFG., SANTA MONICA, CALIF., JAN. 6, 1942.

A cigarette butt was dropped through a screened air conditioning system suction opening in the floor of the office section on the first story of this sprinklered 2-story fire-resistive building. The opening was to a 40-ft.-long concrete tunnel under the floor that led to the blower fan in the boiler room. From the boiler room the air was blown through overhead 14-gauge sheet metal ducts to various portions of the building. The ducts were entirely noncombustible except for a combustible fibreboard sound trap installed in the underfloor duct. It was this material that was ignited by the cigarette. Flames escaped through ducts at the blower fan in the boiler room where three sprinklers operated to hold them in check until extinguished by hose streams. Loss, $1,072. (See also NFPA Standard No. 90, Sec. 111.)

HOTEL, BOSTON, MASS., FEB. 20, 1943.

A cigarette carelessly discarded into an air conditioning duct opening in the first floor cocktail lounge was the reported cause of a fire discovered in the metal duct in the basement of the 15-story fire-resistive building. Although the fire department responded promptly, employees had extinguished the small fire with first aid extinguishers before the arrival of apparatus.

Fresh air intakes shall be protected by screens of corrosion-resistant material not larger than one-half-inch mesh. **NFPA Standard No. 90, Sec. 143.**

CLOTHING STORE, BOSTON, MASS., AUG. 7, 1942.

The fresh air intake to the air conditioning system for this 7-story fire-resistive building consisted of a screened opening in the sidewalk. Fire broke out in the intake duct in the basement when a discarded cigarette entered the intake through a hole in the defective sidewalk screen and ignited lint in the duct. Firemen summoned by an employee at 8:06 P.M. quickly extinguished the fire in the duct with hand extinguishers. The building was sprinklered, but due to the location of the fire in the duct, none operated. (See also NFPA Standard No. 90, Sec. 144.)

MULTIPLE OCCUPANCY, SAN FRANCISCO, CALIFORNIA, NOV. 27, 1943.

A discarded cigarette drawn into the cold air suction intake of the air conditioning system was the probable cause of fire in the basement of this 4-story brick, heavy timber building. The alarm was transmitted simultaneously at 11:20 A.M. by a drug store employee who smelled smoke, and by the central station supervised water-flow alarm on the sprinkler system. Responding firemen quickly extinguished fire found in a small amount of combustible material on the filter. The sprinkler that transmitted the alarm was 50 ft. from the fire and had been operated by heat discharging from a duct opening.

Air Filters

Air filters shall be of approved types that will not burn freely or emit large volume of smoke or other objectionable products of combustion when attacked by flames. **NFPA Standard No. 90, Sec. 151 (a).**

FIVE AND TEN CENT STORE, WORCESTER, MASS., JUNE 26, 1946.

Oil coated filters of air conditioning equipment located on the third floor of this sprinklered 3-story brick, wood-joisted building were found on fire by an employee one hour after workmen had made minor repairs with a welding torch outside the metal enclosure housing the filters.

Part of the air conditioning equipment consisted of a canvas curtain inside the filter enclosure that was operated by a cord extending outside. It is thought that the torch or sparks started a smoldering fire in the cord which spread to the curtain and thence to the oily filters. Fans were quickly shut down but not before considerable smoke had been blown into the first floor and basement. The fire was confined to the filter enclosure by use of chemical extinguishers and a booster line. As a precautionary measure, one sprinkler was opened by the building engineer when flames broke into the open from the door opening of the filter enclosure. (See also NFPA Standard No. 90, Secs. 172 and 201.)

The installation of approved automatic extinguishing equipment employing water, gas or other approved means in the enclosure of the air conditioning system to protect against combustion of material that may accumulate is recommended for systems other than those of the unit or cabinet type with blower capacity not exceeding 20,000 cubic feet per minute and which supply only one floor area or a portion thereof. Where sprinklers are installed, suitable provision should be made for drainage including adequate provision for overflow drains from any oil reservoirs installed at filters. In buildings not equipped with automatic sprinklers, the water supply may be taken from the house piping, if the supply is adequate for the purpose. **NFPA Standard No. 90, Sec. 151 (b).**

COPPER SMELTING, PERTH AMBOY, N. J., FEB. 16, 1939.

The ventilation system* which had been used for several years during the summer to cool the transformer room was undergoing cleaning and repairs to the filter when fire broke out. The filter was 6 ft. in diameter and 7 ft. long, the filter medium being ½-inch-thick copper gauze supported between screens and soaked with heavy oil.

Because of the close clearance between the blower room walls and the filter, it was impossible to slide the completely assembled drip pan under the filter. For this reason, as at other infrequent times when it was necessary to replace the drip pan, it was the practice to spot weld the sides to the bottom while in position beneath the filter. The pan was being assembled in this manner when the fire broke out. Weld-

*Note: Information on the capacity of this system is not available. It is not possible to determine whether the recommendations of Section 151 (b) applied. However, this fire indicates the advisability of automatic protection irrespective of capacity.

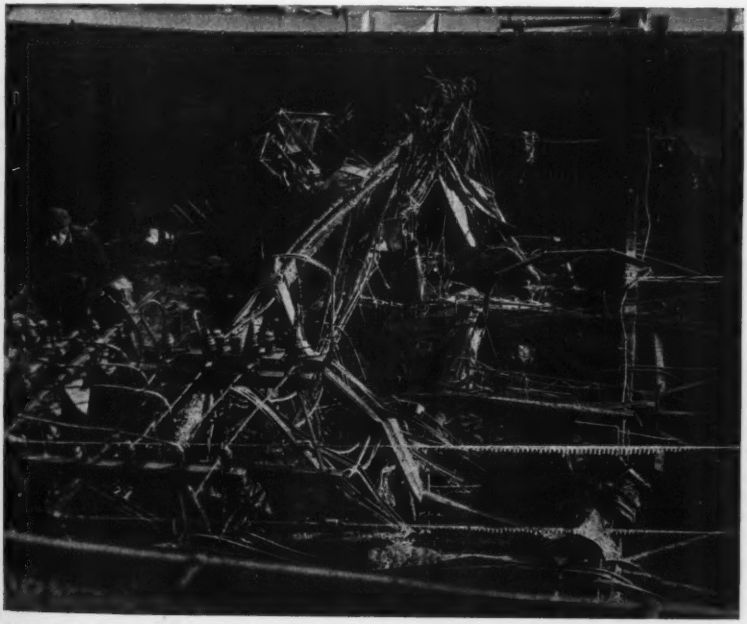
ing sparks ignited the oil-soaked gauze, fire gained intensity quickly, spread to another filter, and burned out the wood-framed door and windows of the blower room. The plant fire department had the fire out in 20 minutes.

DEPARTMENT STORE, MEMPHIS, TENN., JULY 29, 1940.

Workmen were replacing a steel column adjacent to an air conditioning filter enclosure on the fourth floor of this 8-story building. Since the installation of the column involved oxyacetylene cutting, one man had been stationed inside the enclosure to intercept flying sparks. Despite this precaution, the lint on the steel wool filter was ignited. A sprinkler head in the enclosure operated to extinguish the fire and summon the fire department through a central station supervised waterflow alarm. Loss was $25.00.

OFFICE BUILDING, BALTIMORE, MD., MAR. 2, 1942.

Bridging of two potentials with oily lint and dirt caused fire in one of six electromatic air filters installed in the penthouse to condition air for the 4-story office building. Smoke coming from fourth story air outlets was the first indication of the fire. Hastily summoned building employees went immediately to the plenum chamber in the penthouse, shut down the fan, attacked the fire with carbon dioxide extinguishers and after the fire had been apparently extinguished turned the fan on slowly to rid the building of smoke. This action, however, caused the fire to blaze up freely again and filled the penthouse with so much smoke that the employees were forced to leave before turning off the fan. The intense fire in the unit ignited the cork covering on the outside of the plenum chamber, although the cork insulation was covered with cement plaster. Joints in the cooling system were opened, releasing freon, and sufficient heat was generated to operate one sprinkler in the penthouse. Simultaneous alarms by an outsider and the central station supervised waterflow alarm summoned the fire department, which quickly completed extinguishment with



Chicago Daily News

This twisted mass was all that remained of bowling alleys in Chicago, following a fire on January 4, 1945. When heated, the metal ducts, supported by the lower chord of the wood trusses, helped to spread the fire throughout the large unprotected attic space. **(See page 150.)**

Acme

The air conditioning system was reported to have been a major factor in the destruction of this night club at Hollywood, Calif., June 27, 1943. Fire originated in the cocktail lounge and spread through ducts to the attic. (See page 153.)

one hose stream. As a result of this fire it was decided to install sprinklers in the plenum chamber and provide an automatic fan control, a manual shut down emergency switch and a photo-electric smoke detector. Loss $4,000. (See also NFPA Standard No. 90, Secs. 171 and 201.)

OFFICE BUILDING, MILWAUKEE, WISC., APR. 9, 1943.

One of the several air conditioning systems in this 6-story building was located on the fifth floor and served a group of offices on the floor below. A filter of the unit was contained in a chamber of 14-gage steel plate, with 1-inch cork insulation on the exterior and was of the electrostatic type in which slowly moving electrically charged baffle plates pass through a bath of oil in a tank at the bottom of the assembly. A foam extinguishing system protected the oil storage tank but no automatic protection was provided for the filter nor was there an automatic temperature limit switch interlocked with the fan motor control.

During the night before the fire, deposits had been removed from the baffle plates and early the following morning all guard screens were removed and accessible parts cleaned. Soon after this procedure, flames were seen to break out on the baffle plates just above the adhesive tank and spread to the filter. The foam extinguishing system operated effectively to protect the storage tank, but carbon tetrachloride and soda acid extinguishers were ineffective on the filter fire which repeatedly ignited from the hot metal after each extinguisher charge had been exhausted. Heat from the blaze was sufficient to melt parts of a wire screen, die-cast thermostat housings and lamp guards, warp the metal filter baffles and ignite the cork insulation on the exterior of the housing. Smoke was discharged into the conditioned offices. Fortunately the fan motor switch was in an accessible location and could be reached by the building engineer when summoned; otherwise the damage would probably have been more extensive.

SIGNAL EQUIPMENT MFG., BOSTON, MASS., MAY 25, 1948.

The crystal assembly room on the first floor of the 9-story sprinklered, fire-resistive building was serviced by a self-contained, air conditioning system. Air was taken from a louver on the outside wall of the building through the electromatic filter and was discharged via ducts (not equipped with automatic dampers) to the crystal assembly room.

Fire of unknown cause originated in and was confined to the electromatic filter. Six sprinklers operated, three in the vicinity of the filter and three toward the rear of the room which were fused by heat discharging from the duct; but water could not reach the fire inside the filter housing. On discovery of the fire at 7:10 P.M., the fire department was summoned at once. The fire was not finally extinguished, however, until firemen shut down the blower fan at 7:40 P.M. by pulling the main control switch at the main switchboard panel, and inserted a 2½-in. hose in a hole chopped in the filter housing. Water damage to crystals comprised most of the $200,000 property damage. (See also NFPA Standard No. 90, Sec. 171.)

All air filters shall be kept free of excess dust and combustible material. Unit filters shall be renewed or cleaned when the resistance to air flow has increased to five times the original resistance or when it has reached a maximum of 0.5-in. water gauge, whichever is higher. A suitable draft gauge should be provided for the purpose. Draft gauges, of a type which will operate a warning light or produce an audible signal when excessive dust loads have accumulated, are recommended. If the filters are of the automatic liquid adhesive type, sludge shall be regularly removed from the liquid adhesive reservoir. **NFPA Standard No. 90, Sec. 155.**

MULTIPLE OCCUPANCY, NASHVILLE, TENN., APR. 20, 1943.

Fire originating in the roof house atop the 7-story building has been attributed to laxity in maintenance of air conditioning equipment. The irregular removal of sludge from the filter elements of the electromatic type filter is believed to have caused voltage to drop on the plates, causing, in turn, increase in amperage and resulting flashovers or continuous arcs. Although fire was confined to the roof house by three hose streams and sprinklers, lack of a smoke actuated automatic device in the down stream side of the filters permitted smoke to be blown to various parts of the building. Total damage, including use and occupancy, $20,600. (See also NFPA Standard No. 90, Sec. 201.)

Fans

When installed, fans shall be so located and arranged as to afford ready access for repairing, cleaning, inspection and lubricating. They should be placed on proper foundations or firmly secured to substantial supports. **NFPA Standard No. 90, Sec. 162.**

STORES AND VETERANS CLUB, BURLINGTON, IOWA., APR. 17, 1949.

Overheating of a ventilating fan due to lack of lubrication was the probable cause of fire that broke out above the first floor lavatory in the concealed ceiling space. Fire spread through vegetable fiber insulation above the suspended ceiling and into the second floor through pipe openings. Loss, $32,600.

Controls

Each installation shall be equipped with a manual emergency stop, located at a conveniently accessible point, for quick shutting down of the fan in case of fire. This location should be submitted to the inspection department having jurisdiction for approval. **NFPA Standard No. 90, Sec. 171.**

MULTIPLE OCCUPANCY, CLAREMONT, N. H., NOV. 28, 1941.

A cigarette carelessly tossed into a paper box in front of the air conditioning system blower in the basement caused fire that practically destroyed this 2-story brick veneer, wood-framed building housing stores and offices. When first discovered fire was confined to the box, but before a blanket could be obtained from another room to smother the blaze, the fire had been pulled into the air conditioning system. Flames were coming from all air-duct openings on upper floors when apparatus arrived. Due to inaccessibility of the shut-off switch in the basement, the blower continued in operation for some time, greatly hampering attempts at fire control and was not shut down until wires to the building were cut by light company employees. Loss, $100,000. (See also NFPA Standard No. 90, Sec. 144.)

MULTIPLE OCCUPANCY, MONTREAL, QUE., MAY 18, 1942.

Several stores were destroyed by fire that originated in the basement of the 3-story brick, wood-joisted building that housed them. Fire spread from the basement through the air conditioning ducts when firemen were unable to get into the basement to turn off the fan switch. Fire also spread to upper floors through nonfirestopped walls. Loss, $100,000.

BOWLING ALLEY, INDEPENDENCE, MO., AUG. 5, 1944.

Opening night for this bowling alley proved to be disastrous when flames burst from a small refinishing room where highly flammable liquids were stored and sent patrons fleeing to the exits. The one-story masonry walled building had been closed for a period of about two weeks for refinishing of alleys and pins and general overhaul. Open cans of lacquer and finishing liquids were ignited in the stockroom from an unknown source. Since the air conditioning control switch could not be reached to shut off the blowers, air from the system fed the blaze as it spread rapidly across the newly finished alleys and up the combustible fibreboard walls. Loss, $70,000.

FILM LABORATORY, ETOBICOKE, ONT., FEB. 12, 1948.

Fire occurred in the sprinklered positive assembly room (21 ft. x 12 ft.) in this one-story masonry walled, metal roofed building when film was accidentally held against or too close to a portable 100 watt lamp. Walls of the assembly room were constructed of 4-inch concrete block, and the only opening other than air duct openings was closed by a tight fitting door. An air conditioning system provided ventilation.

Gases from the burning film filled the assembly room and spread to the adjoining boiler room preventing firemen from entering the boiler room where the switch for the air conditioning system was located. Consequently, since there was no provision for automatic shut down of fans in case of fire, air was continually fed to the fire area. The sprinklers operated and held the fire in check in the assembly room until the excessive pressure generated by the rapid burning of the 75,000 feet of exposed film blew off the roof and knocked down the four walls of the room and moved several other walls in the 8,200 square foot building. Loss was $75,000.

In system utilizing re-circulation, serving more than one story of a building, or more than one fire section of a single story, fans shall be arranged to shut down automatically when the temperature of the air in the system becomes excessive, as from a fire. For this purpose an approved thermostatic device, with a setting not in excess of 125°F., shall be located in the system at a suitable point in the return air duct ahead of the fresh air intake. **NFPA Standard No. 90, Sec. 172.**

DEPARTMENT STORE, ENID, OKLA., FEB. 16, 1950.

A watchman who made unsupervised rounds through the unsprinklered 2-story fire-resistive store at irregular intervals was not aware of fire in the basement until 3:24 A.M. when he noticed the odor of smoke while on the mezzanine floor. Although dense smoke made fire fighting extremely difficult, firemen were able to confine the flames to the shipping and receiving room separated from the rest of the basement by an 8-inch hollow tile wall with wooden doors. Operation of the air-conditioning system during the fire and absence of automatic dampers in air conditioning ducts resulted in severe smoke and heat damage to stock throughout the building. Loss, $389,000.

Electric Wiring and Equipment

Motors shall be located so that maintenance, such as oiling of bearings and replacing of brushes, can readily be accomplished. Open motors having commutators or collector rings shall be located or protected so that sparks cannot reach adjacent combustible material. Motors installed inside air ducts or plenum chambers, or inside unit type air conditioning equipment should be provided with over temperature protection devices designed to cut off current before temperatures reach a point where smoke may be generated. **NFPA Standard No. 90, Sec. 182.**

BOWLING ALLEY, SANTA MONICA, CALIF., SEPT. 18, 1944.

Fire started in the cockloft of this single story brick, wood-joisted unsprinklered building when the electric motor driving the air conditioning system became overheated and caused ignition of the combustible attic. The fire was discovered when live coals dropped through ventilator grilles onto the alleys. Damage was confined to the attic and the roof. Loss, $108,000.

CHINCHILLA BREEDING FARM, INGLEWOOD, CALIF., SEPT. 28, 1944.

An overheated motor on the air conditioning unit was the probable cause of fire that spread through the air ducts, nonfirestopped walls, cockloft and concealed areas between ceilings and floors of this wood-frame, stucco-clad building housing chinchillas in pens on the first floor and in the basement. A passing motorist saw smoke coming from the building at 6:45 A.M. and notified the owner, who promptly

called the fire department. Fire was extinguished without much trouble with the use of two booster lines, but many valuable chinchillas had already suffocated from heat and smoke. Loss, $131,700. (See also NFPA Standard No. 90, Sec. 201.)

Cooling and Heating Equipment

Mechanical refrigeration shall be installed in accordance with the safety Code for Mechanical Refrigeration (A.S.A.—B9). **NFPA Standard No. 90, Sec. 191.**

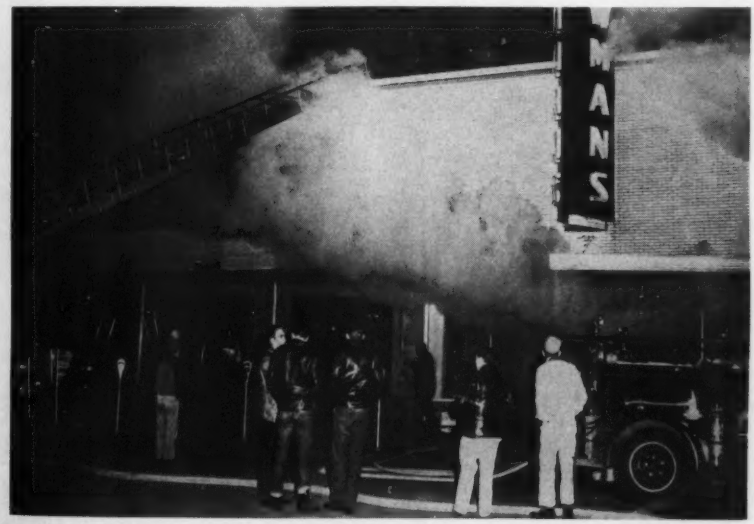
THEATRE, FAIRLAWN, N. J., JUNE 27, 1943.

An explosion of methyl chloride refrigerant occurred in the basement compressor room of the 1- and 2-story theatre during the evening performance. The force of the explosion lifted part of the first floor, broke plate glass windows and shattered the front sidewalk. With the exception of 6 patrons treated for smoke inhalation and shock, the 800 attendants filed out without casualty. A theatre employee was badly burned attempting to extinguish the small fire that broke out on the first floor. The air conditioning unit was designed for use of nonflammable "Freon 12" refrigerant (Group 1), but due to government restrictions flammable methyl chloride (Group 2) had been substituted two days prior to the explosion. Since changes had not been made in the system to meet requirements for systems using Group 2 refrigerants as set forth in the Safety Code for Mechanical Refrigeration, the system was thereby substandard.

Water-cooled condenser coils were on the roof of the first story section outside the second story projection booth, and the first indication that something was wrong was the discovery by the booth operator that water was not flowing over the coils. He investigated further and had just entered the basement when a compressor started up and methyl chloride began to escape from a lead-sweated copper pipe joint above the compressor. Explosion of the gas occurred immediately thereafter. The ignition cause is unknown.

DEPARTMENT STORE, DALLAS, TEXAS, NOV. 19, 1948.

At 2:30 A.M., cruising police noticed what appeared to be smoke issuing from a first-floor vent serving the engine room exhaust system, and upon investigation noticed a strong odor of ammonia. The alarm was sent in at once, and firemen were about to enter the building when an explosion occurred in the basement engine



Fire in this department store in Enid, Oklahoma, Feb. 16, 1950, was confined to the shipping and receiving room in the basement. However, because the air conditioning system continued in operation during the fire and because ducts were not equipped with automatic dampers, severe heat and smoke damage was caused to stock throughout the building. (See page 160.)

Press Association

This hotel at Susanville, Calif., was heavily damaged by fire on July 24, 1947. Two men were trapped in the basement. Heavy smoke permeated the three-story building through ventilation ducts and was so thick in the basement that firemen could not determine or reach the source of the fire. **(See page 165.)**

room. Fire flashed into the adjacent stock storage area singeing stock, cartons, pipe coverings and wooden shelving, but had been completely extinguished by 46 sprinklers by the time firemen were able to make their way to the basement. The blast also entered air conditioning ducts, causing a considerable amount of dust to be blown into some areas on the upper floors of the 5-story fire-resistive store. Six plate glass windows, located on the first floor near duct openings, were shattered by the blast.

Investigation revealed that a cooling tank containing ammonia refrigerant had ruptured at the fillet around the flange support at the header, allowing ammonia to escape into the engine room where it ignited at a gas-fired water heater. Since the fire door in the fire-resistive engine room was held open by a rope and fusible link, flames flashed through ammonia that had previously flowed into the storage area. Loss was approximately $200,000.

Heating equipment shall be installed in a standard manner with due regard to proper clearance between hot surfaces and woodwork and other combustible materials. **NFPA Standard No. 90, Sec. 192.**

DRY GOODS STORE, MONTGOMERY, ALA., FEB. 27, 1947.

Fire occurred at the ceiling of the second floor directly above the air conditioning unit that supplied warm air through suspended ducts to the second story of the sprinklered brick, wood-joisted building. Natural gas was used as fuel for the heating unit and supply pipes were provided with electrically controlled regulating and shut-off valves and safety pilot controls. The unit was properly vented to the outside of the building and the gas supply was arranged to shut off automatically in the event of power failure or pilot flame extinguishment. It is believed that the thermostat controlling the maximum temperature failed to function, allowing the unit to overheat and burst into flame. Fire spread to the combustible sheathed ceiling and burned a hole six feet in diameter through the third story flooring. Five sprinklers on the second floor and two on the third extinguished the fire. Loss, $25,000.

DRY GOODS STORE, FORT WORTH, TEXAS, AUG. 17, 1948.

Operation of the central station supervised burglar alarm at 9:52 A.M. on this Sunday morning was the first indication of trouble at the unsprinklered 2-story brick, wood-joisted ladies apparel store. On investigation a sizable fire was discovered in the rear storeroom on the first floor that had burned through the ceiling and into the second story before apparatus arrived. A defective thermostat on air conditioning equipment that permitted the unit to overheat and ignite combustible walls and merchandise was the cause of the fire. Hose streams directed through doors and windows and others that were worked in through the sales area to the rear storeroom successfully controlled the fire. Smoke and water damage to stock comprised most of the $141,000 loss.

ROADHOUSE, WHEELING, W. VA., APR. 9, 1949.

At 6:59 A.M. a laundryman delivering linen discovered fire that destroyed the two upper floors and roof of this 2-story brick, wood-joisted building. Origin was a ceiling type gas heater installed in a duct of the air conditioning system and located in a dead air space between two rooms on the second floor. For several days the heater had not operated properly and on the afternoon preceding the fire, the solenoid switch had been replaced. Rapid spread of the fire was attributed to the continuous operation of the air conditioning system. Loss, $75,000.

OFFICE BUILDING, PHILADELPHIA, PA., MARCH 7, 1950.

Because of space limitations, inadequate clearance had been provided between the electric heating grid and the fibreglass filters on the combination heating and air conditioning unit in the basement of this two-story office building. When the heating unit was turned on by someone who did not realize the necessity of starting the blower fan at the same time, the paper binding on the filters ignited. Firemen, summoned by employees who detected smoke coming from air ducts, extinguished the fire by removing the filters. Because of this and a similar previous fire, a mechanical device has been installed to prevent operation of the grid without the blower.

Smoke Detectors

Effective means of detecting and controlling the spread of smoke in air conditioning systems is recommended in premises where the panic hazard is pronounced or where there are valuable contents particularly subject to smoke damage. . . . Photo-electric devices are now available which can be arranged to sound alarms, shut down fans, close damp-

Press Association
This hotel at Susanville, Calif., was heavily damaged by fire on July 24, 1947. Two men were trapped in the basement. Heavy smoke permeated the three-story building through ventilation ducts and was so thick in the basement that firemen could not determine or reach the source of the fire. **(See page 165.)**

Plenum chamber of Toledo, Ohio, department store where fire broke out on June 29, 1940. Fire was confined to the plenum chamber, but the several thousand persons evacuated the store when smoke discharging through air conditioning ducts permeated to all floors of the building. The system lacked automatic controls and the manual shut-off switch in the plenum chamber was inaccessible during the early part of the fire. (See page 165.)

W. L. Heaton, Fire Marshal

Three of five men relocating an air conditioning system motor were trapped in the basement of this department store in Austin, Texas, when fire broke out on March 23, 1950. Molten sulfur being used by the men to fill spaces around motor foundation lag bolts spilled and ignited congested stock near by. (See page 166.)

ers, actuate fire extinguishing equipment or perform other functions. **NFPA Standard No. 90, Sec. 201.**

MOTION PICTURE THEATRE, MT. CARMEL, ILL., MAR. 5, 1939.

Ignition of combustible material used to insulate the cold water tank of the air conditioning system resulted in destruction of the high 1-story brick, wood-joisted theatre. The water tank was located in a small skeleton metalclad structure outside the theatre that adjoined and communicated with the auditorium at the roof through a metal air duct.

On the morning of the day previous to the fire workmen using a welding torch to make repairs to the cold water tank set fire to the insulation, a fibre material that burned rather slowly and emitted a considerable quantity of smoke. A pail of water apparently put the fire out but during the afternoon and again in the evening smoke was detected in the theatre. Each time the usher found the tank insulation still burning and each time from all appearances a pail of water extinguished it. At 1:00 A.M., however, the theatre was found charged with smoke by an outsider and this time the fire department was called. Although the theatre was full of smoke that had entered through air conditioning ducts, once again fire only involved insulation on the cold storage tank. A booster line extinguished the fire quickly, but just as firemen were about to leave an explosion occurred in the theatre followed by a rapidly spreading fire that was not extinguished until all combustible material in the building was consumed. It is assumed that the burning insulation had liberated carbon monoxide that passed through ducts into the theatre in sufficient quantity to form an explosive mixture. The ignition source is unknown. Loss was approximately $50,000.

DEPARTMENT STORE, TOLEDO, OHIO, JUNE 29, 1940.

On a busy Saturday afternoon fire broke out in the plenum chamber of the air conditioning system serving the first floor of this sprinklered 4-story brick, heavy timber-joisted store. The several thousand people in the building left without panic under the guidance of store employees as smoke spread to all floors.

The capacity of the system was 67,200 cubic feet per minute. Fresh air from window louvers was passed through fibreglass filters in the plenum chamber, warmed or cooled, and blown through horizontal ducts fastened to the ceiling to various sections of the first story. Return air was drawn directly into the plenum chamber from the adjoining sales area through a wall intake at floor level and protected by a 1½-inch mesh wire screen.

Cause of the fire is unknown, although combustible material drawn into the air intake may have been ignited by a carelessly discarded cigarette. The combustible floor covering of the plenum chamber was ignited and that part of the smoke that was not removed by the filters was drawn through them and distributed throughout the first floor and two upper floors through open stairways. The fire was discovered promptly, but due to the inaccessibility of the manual control in the plenum chamber, the blower operated for some time after discovery until the engineer was able to work his way into the chamber and pull the control switch. The two sprinklers extinguished the fire in the plenum chamber except for flames that had entered partitions. The latter were extinguished by the fire department. Loss, $17,000. After the fire, automatic heat controls were installed in the intake and in the plenum chamber and remote manual controls were placed on the first floor and the basement.

DEPARTMENT STORE, DALLAS, TEXAS, NOV. 29, 1946.

An area of 700 sq. ft. in the basement of the 5-story fire-resistive building was severely damaged by fire originating near the power switchboard in an unsprinklered section of the basement. Window decorators first detected smoke coming from the air conditioning grille on the mezzanine floor (system not in operation) and summoned the fire department at 11:57 P.M. Heat, smoke, and excessive stock piling prevented firemen from reaching the base of the flames from the two narrow stairways. Finally, a small hole in the floor was located and two distributing nozzles lowered to cool the area, permitting firemen to descend the stairways. Fire damage was confined to the basement, but smoke spread throughout the building via air conditioning ducts, causing heavy damage to stock on the first floor and moderate damage above. Loss, $925,000.

HOTEL, SUSANVILLE, CALIF., JULY 24, 1947.

Air conditioning ducts were responsible for almost total destruction of this 3-story concrete walled, wood-joisted hotel. Fire that originated in a basement office generated smoke so rapidly that two men were trapped before they could escape, and firemen who were summoned without delay were unable to enter the basement. Holes were made in the first floor, but before water could be discharged into the basement flames had entered air conditioning ducts and had spread via the ducts throughout the building. Loss, $710,000.

were trapped in the basement of this department store in Austin, Texas, when fire broke out on March 23, 1950. Molten sulfur being used by the men to fill spaces around motor foundation lag bolts spilled and ignited congested stock near by. (See page 166.)

broke out on June 29, 1940. Fire was confined to the plenum chamber, but the several thousand persons evacuated the store when smoke discharging through air conditioning ducts permeated to all floors of the building. The system lacked automatic controls and the location of the shut-off switch in the plenum chamber was inaccessible during the early part of the fire. (See page 165.)

Maintenance

Unit filters should be renewed or cleaned when the resistance to air flow has increased to five times the original resistance or when it has reached a maximum of 0.5 inches water gauge, whichever is higher. A suitable draft gauge should be provided for the purpose. Draft gauges, of a type which will operate a warning light or produce an audible signal when excessive dust loads have accumulated, are recommended. **NFPA Standard No. 90, Appendix Sec. 4 (a).**

OFFICE BUILDING, YOUNGSTOWN, OHIO, AUG. 13, 1947.

The hazard of using highly flammable solvents when cleaning air filters was demonstrated by a fire that burned out the basement of this 3-story office building. In this instance, gasoline being used was reportedly ignited by sparks caused by friction of the cleaning brush. Despite prompt discovery, fire spread rapidly through the basement and required four fire department hose streams for extinguishment. Loss, $21,300.

Fans and fan motors should be inspected at least quarterly, and cleaned and lubricated when necessary. Care should be exercised in lubricating fans to avoid allowing oil to run onto the fan blades. Fans should also be checked for alignment, and to see that they are running freely. **NFPA Standard No. 90, Appendix Sec. 5 (a).**

FLYING SCHOOL BARRACKS, BLYTHE, CALIF., OCT. 8, 1942.

At 9:30 A.M. a cadet detected fire in the unsprinklered 1-story wooden building used as a barracks for air cadets. On discovery the occupants of the building, led by one of their number who was formerly a fireman, extinguished the blaze with a 2½-inch hose stream.

Inspection revealed that the air conditioning fan which was located in the roof area and served a group of buildings, had developed slippage of a belt. The heat generated by the slipping belt was sufficient to ignite the combustible enclosure. Loss, $1,200.

TEXTILE MILL, GREENVILLE, S. C., APR. 3, 1950.

A short circuit in the air conditioning motor ignited accumulations of lint on the ducts and structural members of the brick, wood-joisted building. Fire crept along the top of ducts and beams, dropping off at several locations. The fire was discovered by the watchman at 1:30 A.M. and extinguished by the fire department with hand hose and first aid extinguishers. Loss, $50,000.

Note: NFPA Standard No. 90 discourages the use of combustible coverings on ducts (Section 11(b)) but does not specifically mention the hazard of combustible dust accumulations on top of ducts. Periodic removal of such accumulations from ledges, pipes, ducts and other surfaces is one of the fundamentals of any plant fire prevention program.

Great caution should be exercised in the use of open flames or spark emitting devices, inside of ducts or plenum chambers, or near air intakes. (See Standards, paragraph 115.) **NFPA Standard No. 90, Appendix Sec. 7.**

DEPARTMENT STORE, AUSTIN TEXAS, MAR. 23, 1950.

Three of five men relocating the motor of the air conditioning system were trapped when fire flashed over near-by merchandise stacked to the ceiling in the basement of the unsprinklered 3-story brick, wood-joisted department store. The fire marshal's report indicates that an overturned ladle of molten sulphur caused the fire (old timers occasionally have used molten sulphur to fill the space around the fan motor foundation lag bolts.) One of the men raced up the basement stairs before flames cut off this exit. Others tried to escape through a ten-inch square wall opening. Only one was successful. Fire was confined to the basement, but because of dense smoke could not be extinguished before the first floor collapsed and the basement had been flooded. Loss, $250,000.

OFFICE BUILDING, NEW YORK, N. Y., APR. 7, 1950.

Fire, reported by street box at 1:04 A.M. involved a room approximately 20 feet square and 50 feet of a corridor on the twenty-third floor of this 48-story fire-resistive building. Sparks from a welding operation on the air conditioning system were the probable cause. Flames destroyed the contents of the room and badly damaged the interior finish, plaster and electrical equipment. Firemen extinguished the blaze with building standpipe lines supplied by gravity tanks and basement pumps. However, when it was found impossible to shut off the standpipe due to poorly designed valves, water caused additional damage until shut off at gravity tanks. Loss, $100,000.

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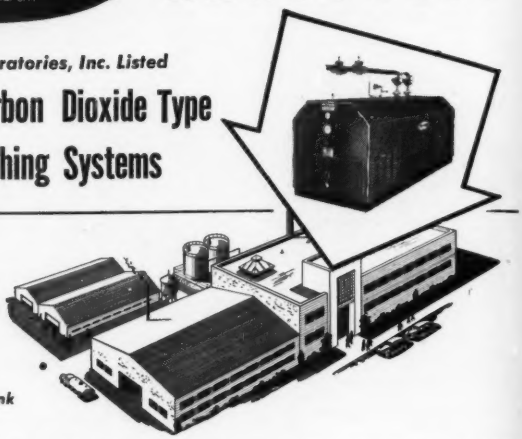

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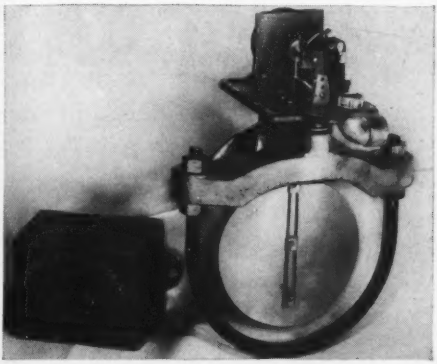

5-inch size shown above. To install simply drill hole in pipe.

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Waterflow Alarm Device is approved by both the Factory Mutual Laboratories and Underwriters' Laboratories, Inc. In hundreds of installations it has proved to be the ideal alarm device for sprinkler systems.

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By installing this most economical alarm device, you will know instantly where the water is flowing. Many plants are having them installed on each floor or in each section. They save water damage.

This device can also be obtained as Model PRT, a coded waterflow transmitter from which signals are received on a punch register and single stroke gong. Practically any number can be installed on a two-wire system, thus resulting in considerable savings on wiring.

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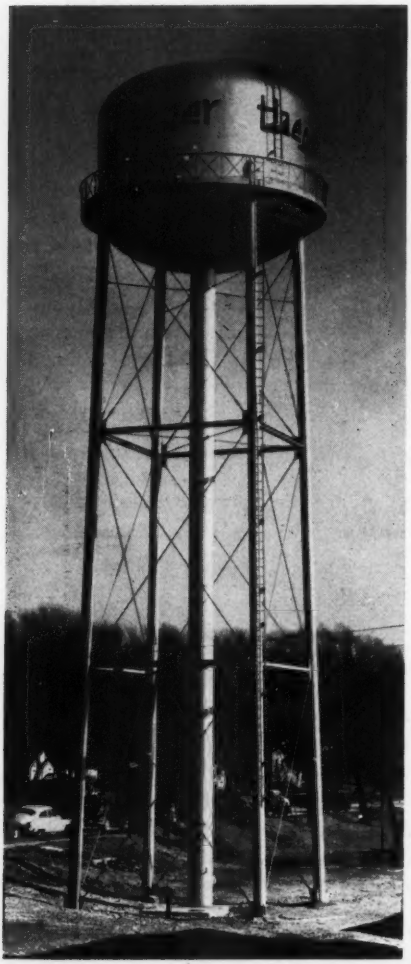

permitted after installation of Elevated Tank

This 75,000-gallon elevated steel tank maintains gravity water pressure in the automatic sprinkler system at the Haeger Potteries, Inc. plant at Dundee, Illinois. The plant contains about 175,000 sq. ft. of floor space. This entire area, with the exception of 1,000 sq. ft., is protected by an automatic sprinkler system.

The elevated tank, which is 80 ft. to the bottom, provides the primary water supply for the fire protection system, and the city water system is used as a secondary source.

Haeger Potteries, Inc. are manufacturers of pottery lamps and artwork of all types which are distributed and sold throughout the world.

Since the installation of the elevated tank, lower insurance rates than had been previously granted, have been permitted.

Write our nearest office for quotations on elevated tank installations. State capacity, height to bottom and location.

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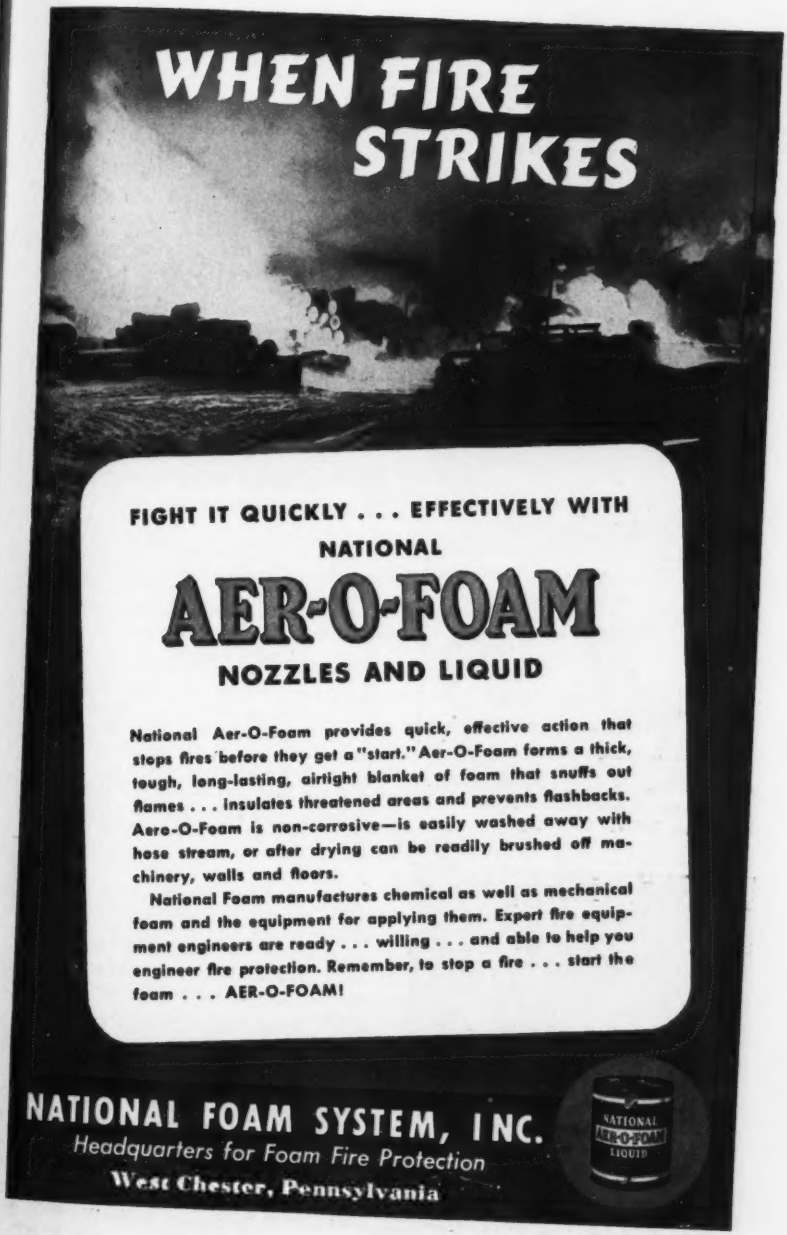
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New valve trigger has automatic safety. If disc ruptures, trigger pushes downward to show words "Replace Disc."

Kidde Fire Extinguishing "know how" brings you still better equipment—a new valve that works surer, quicker, easier.

What happens when you pull the trigger?

When fire strikes, just grab your *Kidde* portable extinguisher and *pull the trigger!* Flame-smothering carbon dioxide gas rushes out . . . kills fire in seconds . . . and does the job *better* because of a new, improved valve.

This improved new valve, on all portables from 2½ to 25 pound size, gives you maximum safety . . . surer, easier trigger-finger control! The valve has a pure nickel coined disc which does triple duty . . . acts as a *seat* for the nylon check, a *safety disc* and a *gasket* between the valve body and the cylinder. Thus, possible leakage points are reduced to only 2 places—less than any other extinguisher of this type.

Extinguisher cylinders used with new valve are externally threaded . . . making easier assembly and disassembly . . . eliminating the possibility of cylinder neck stretching . . . strengthening the union between valve body and cylinder neck.

Here's fire extinguishing at its best. ***When you think of CO_2, call Kidde.***

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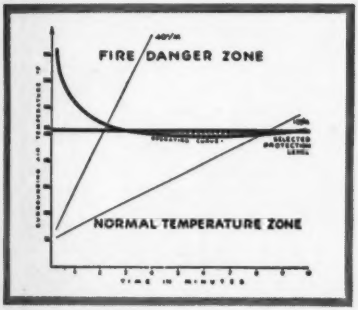
NOW...the most sensitive fire detector adds eye appeal

NEW FENWAL DETECT-A-FIRE horizontal model combines smart design with full protection for ordinary locations. Its temperature range extends to 325°F for release (type 20) application, and alarm (type 21) application.



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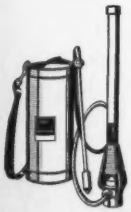
The all-purpose extinguisher effective on almost every kind of fire. Safe on electrical fires, too! 1 qt. and 1½ qt. pump types; 2 qt. (above) and 1 gal. pressure-operated types.



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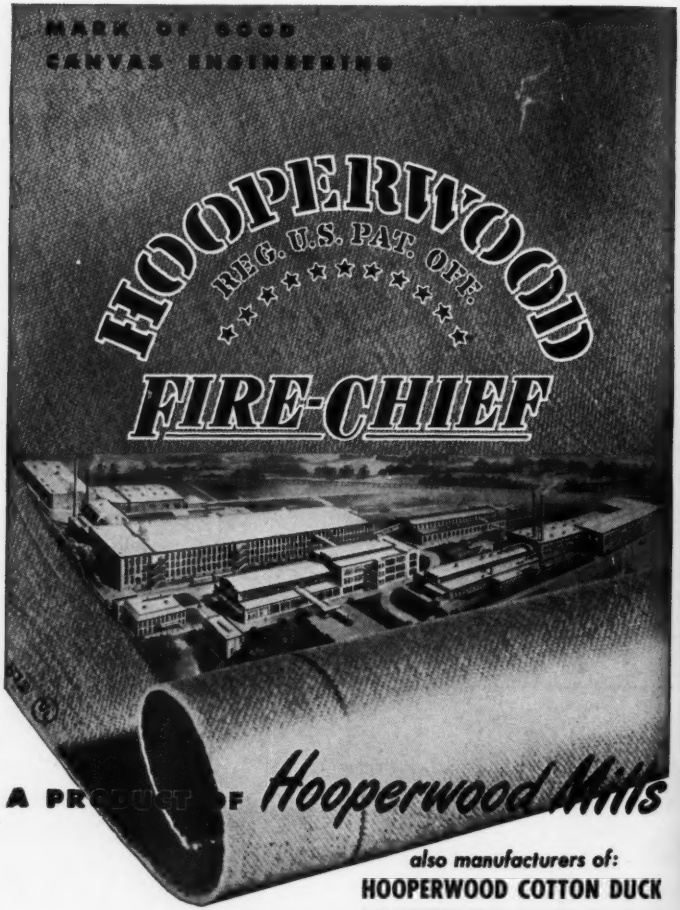

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Entire 3rd Floor cleared of smoke and hot gases immediately permitting firemen to advance into building with handlines in one minute-Fire under control within 5 minutes

A front page newspaper story of a recent fire told of a remarkable job of extinguishing a two alarm fire in a 3 story building by the New Haven Fire Department.

A huge 500 gpm Rockwood WaterFOG Nozzle, utilizing a new type of attack from an aerial ladder, played an important role in putting out this fire. Here, in his own words, are the facts which we were able to obtain directly from Chief Paul P. Heinz of the New Haven Fire Department.

"Attached is a photograph of a recent fire in our city. The Rockwood 500 gpm fog nozzle did an excellent job operating from our aerial ladder.

"The fire originated on the 2nd floor of a 3 story building and extended to the 3rd floor by means of an inside stairway and elevator shaft. The alarm was received at 6:25 P. M. on June 26, 1950 and when the first company arrived, heavy smoke and gases were being forced through the windows on the 3rd floor, front. Hand lines were ordered on the 2nd floor and in the rear but firemen were unable to advance due to extreme heat. A second alarm was transmitted at 6:30 P. M. At 6:35 P. M., the 500 gpm fog nozzle went into operation from our aerial ladder and in less than a minute the entire 3rd floor area was blackened out. The hand lines on the 2nd floor began to advance into the building and within 5 minutes the fire was under control.

"From my observations the big fog nozzle did accomplish two purposes. (1) it cleared the 3rd floor area of smoke and hot gases immediately and (2) the water particles were forced down the elevator shaft and inside stairway, cooling off the floor areas making it possible for the firemen to advance their lines. Our operating pressures at the nozzle was 150 lbs.

"This particular fire, like others we have had in the past, convinces us, more than ever before that broken water will do an excellent job on most any type of fire where the solid stream was considered effective."

Our bulletin B-500 describing the 500 gpm Rockwood WaterFOG Nozzle for use on ladder pipes or deluge guns will be sent to you upon request.

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Figure No. 82M

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Our New Circular No. 49 shows important installation dimensions of M & H AWWA Mechanical Joint Hydrants and Valves . . . Underwriters and Associated Factory Mutual Approved Post Indicator Valves . . . and Cutting-in-Sleeves.

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with no capital investment involved!

Deluge Systems, Wet Pipe Systems, Dry Pipe Systems, Water Spray and Fog Systems, Rate-of-Rise Sprinkler Systems, and Foam and Carbon Dioxide Extinguisher Systems.

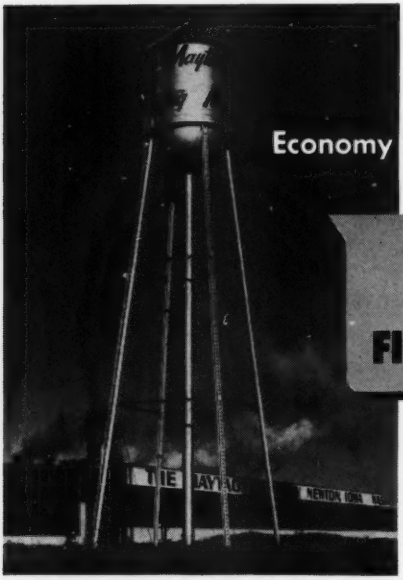
YOUR yearly insurance savings applied to the cost of a Blaw-Knox Fire Protection System converts an existing expense into a capital asset. Reductions from 50 to 90% are effected when lives and property are safeguarded by this fully recognized fire protection—quickly amortizing the entire cost.

At your request a Blaw-Knox Engineer will come to your office for consultation. He will make a survey of your fire hazards, secure your insurance underwriter's requirements, prepare a preliminary layout of a system that will give you the utmost in fire protection, and submit an estimate of costs—all without obligation.

"LITT
JOEY SPR

LAW-KNOX SPRINKLER DIVISION
BLAW-KNOX CONSTRUCTION COMPANY
829 Ave., Pittsburgh 12, Pa.
Offices in

BLAW-KNOX
PROTECTION
SYSTEMS



Economy in water supply

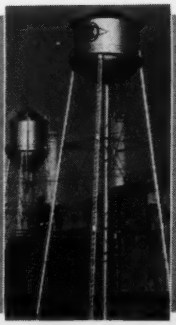
plus
Dependable
FIRE PROTECTION

PITTSBURGH
• DES MOINES

INDUSTRIAL *Elevated Steel Tanks*

Water for process use—for general plant needs—for ever-present sprinkler supply! You're *sure* of dependable water service and protection with storage in a Pittsburgh-Des Moines Tank—your satisfaction is guaranteed by the pioneer builder of elevated steel tanks since 1897. Let us quote on your requirements.

Write today for our complete Elevated Steel Tank Brochure



PITTSBURGH • DES MOINES STEEL CO.

Plants at PITTSBURGH, DES MOINES and SANTA CLARA

Sales Offices at:

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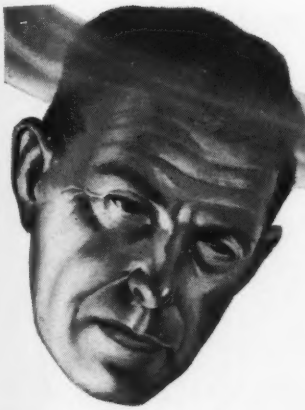
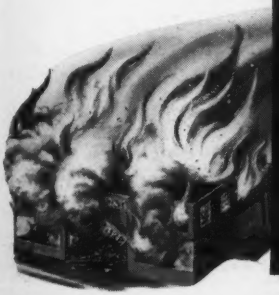
CHICAGO (3). 1272 First National Bank Bldg.
DES MOINES (8). . . . . 969 Tuttle Street
DALLAS (1). . . . 1273 Praetorian Building
SEATTLE . . . . . 976 Lane Street
SANTA CLARA, CAL. . . 675 Alviso Road



The Fire that Burned for Six Months

"For six long months, I watched that one fire burn up my profits and eat into my working capital.

"Firemen put out the flames in six hours, but I was out of business for six months. Profits stopped. Many expenses continued. Insurance partially replaced my store and stock . . . but I'll never recover the profits I lost!"



Business Interruption Insurance Pays Expenses, Replaces Profits

Properly presented, no policy is easier to sell than one which protects profits, working capital and credit standing in case of fire or other catastrophe. More and more agents are discovering that all business firms — small merchants as well as large manufacturers — are live prospects for Business Interruption Insurance.

Our agents find this new folder effective in presenting Business Interruption Insurance.

AUTOMOBILE INSURANCE COMPANY
STANDARD FIRE INSURANCE COMPANY
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FIRE AND MARINE
INSURANCE
ALL FORMS

Affiliated with ÆTNA LIFE INSURANCE COMPANY • ÆTNA CASUALTY & SURETY COMPANY

"Akbar" Doors Automatically Block Flames—*with Safety*—at Hazardous Openings

"Akbar," The Steel Rolling Fire Doors made only by Kinnear, stop fire by cutting off flame-spreading drafts

Kinnear's famous AKBAR Steel Rolling Fire Doors give you *quick, positive*, automatic protection. When fire threatens, they stop dangerous flame-spreading drafts, by blocking openings with a curtain of steel.

Yet their automatic action features special provisions for the safety of building occupants. In emergency release, they are pushed down by a strong starting spring, to assure positive action. Their downward speed is controlled as a safety measure for anyone passing underneath as the doors are released.

Another device stops the door positively at floor level—with the steel door curtain covering the entire opening. The door won't sag, or drop through a fire-weakened sill. In addition, the doors may be opened after automatic closure, for emergency exits.

When not in use, Akbar Doors remain coiled overhead, out of the way. Approved and labeled by Underwriters' Laboratories, Inc., they have saved as much as *one third of their cost per year*, in reduced insurance rates. They are built to fit horizontal openings of any size. Write today for complete information.

Akbar Doors can be equipped for daily service use, with motor operation if desired. However, the regular Kinnear Steel Rolling Doors (non-labeled) are designed for service use where maximum fire protection is not required.

Saving Ways in Doorways

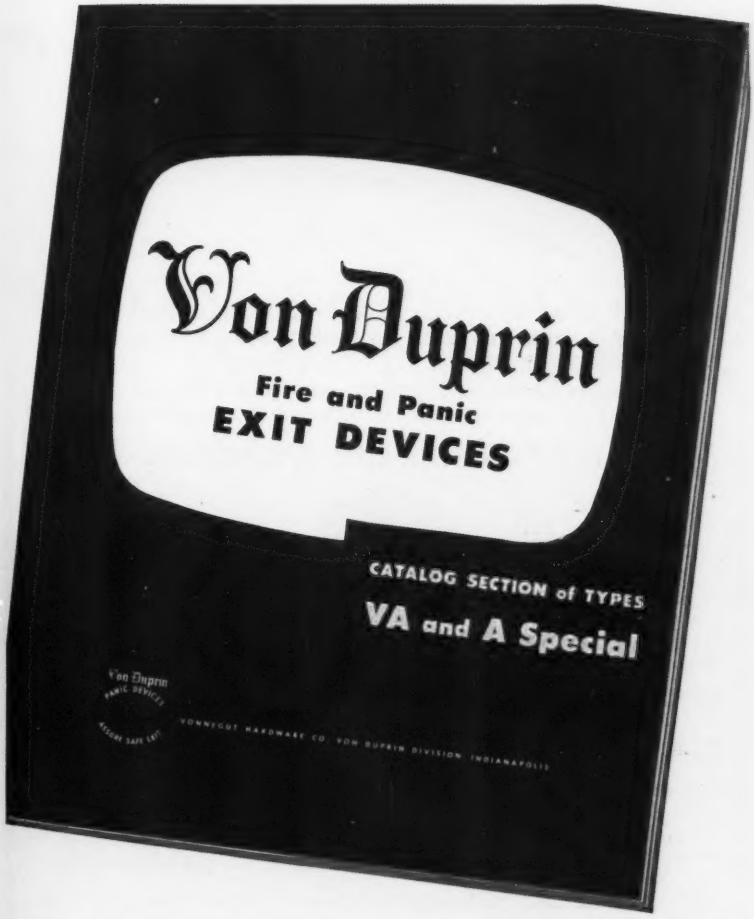
KINNEAR

ROLLING DOORS

The KINNEAR Manufacturing Co.

FACTORIES: 2250-70 Fields Ave., Columbus 16, O.
1742 Yosemite Avenue, San Francisco 24, Calif.

Offices and Agents in All Principal Cities



But It's Really a Handbook

We call it a Catalog Section, but it is also a practical, down to earth handbook on the selection and application of panic exit devices for both single and double doors. It is a condensed brochure, just 8 pages packed with information on Von Duprin types VA and A Special. These devices are in the medium price class, the right types for about 90% of all applications. It's yours on request; just ask for catalog section VA.

VON DUPRIN DIVISION
VONNEGUT HARDWARE CO., INDIANAPOLIS 9, INDIANA

"Eternal Vigilance"

—THE PRICE OF SECURITY!

WHETHER IT BE NATIONAL OR INDIVIDUAL PERFORMANCE . . . SECURITY IS ACHIEVED ONLY BY THE EVER-ALERT, EVER-CAPABLE AND EVER-DEPENDABLE!

All of these requisites for SECURITY against loss of life and property by fire are provided through the "ETERNAL VIGILANCE" of

STAR AUTOMATIC SPRINKLERS

Automatic Sprinklers
Corrosion-Proof Sprinklers
Directional Flow Sprinklers
Open Sprinklers
Spray Sprinklers
Alarm Devices

Automatic Releases
Standard Wet Pipe Systems
Dry Pipe Systems
Deluge Systems
Heat-Actuated Devices
Pre-Action Systems

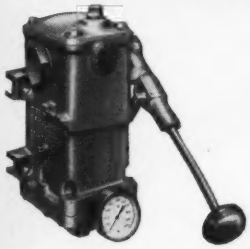
Star Automatic Sprinklers and Fire Protection Devices bear approval of all Insurance Authorities having jurisdiction and various Governmental Agencies.

Economy in installation cost and maintenance has dictated the consistent policy of Star Sprinkler Corporation in distributing its Fire Protection Devices through local licensed contractors who have had a lifetime of experience in the installation of automatic sprinkler systems. Operating throughout the United States, Canada and South America, Star licensees, due to their strategic locations, can render instant service. Write us for name and address of Star licensed contractor nearest your location.

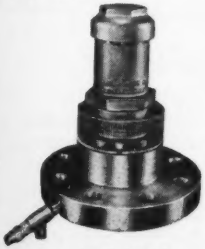
STAR SPRINKLER CORP.

Westmoreland and Collins Sts. — Philadelphia, Pa.

Maximum Safety In L.P.G. Delivery Equipment



S&J Internal Safety Valve Operator.



S&J Internal Safety Valve designed for L.P.G. service.

For maximum safety and dependability in transporting and discharging L.P. Gases, Shand & Jurs has designed a special Internal Safety Valve for use in L.P.G. tanks. It is normally held closed by spring pressure, and can be opened, and held open, only by hydraulic pressure supplied by the operator. A release of this hydraulic pressure will cause the valve to close. If fire occurs near the tank while discharging, small fusible plugs located in the hydraulic lines melt, releasing pressure and allowing any open valve to close instantly. A safety trip installed in conjunction with the hydraulic system will automatically close the valves instantly if truck moves during loading or unloading operations. The S&J Internal Safety Valve is designed to give maximum flow with minimum turbulence and resultant vaporization. Positive, smooth opening of the valve by hydraulic pressure reduces surging, and constant pressure of the internal valve spring causes it to close instantly when hydraulic pressure is released.

SHAND & JURS CO.

BERKELEY, CALIFORNIA

NEW YORK CHICAGO HOUSTON LOS ANGELES SEATTLE

SHAND & JURS

ROLAGRIPS

THE COUPLING FOR PLAIN END PIPE

NOW UNDERWRITERS' APPROVED

for use on Sprinkler Systems

Underwriters' Laboratories have approved Rolagrip Pipe Couplings for use on Sprinkler Systems in all areas.

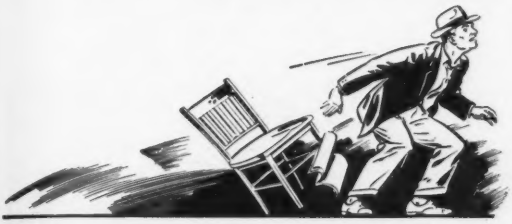
Rolagrips are for *plain end pipe* — no threading, grooving, flanging or welding is necessary. They are made in sizes from 1½" to 12" for use on steel or wrought iron pipe, used or new. Rolagrips are easy to apply — no special tools or skills are required. Every joint becomes a flexible union; every joint can be easily dismantled for repair or clean-out. Rolagrips withstand shock, end pull, vibration, expansion and contraction, and permit misalignment of pipe. They are readily reclaimable — can be used over and over again.

WRITE TODAY FOR PICTURES, PRICES, STRESS CHARTS, FULL DETAILS ON THESE TIME-TESTED COUPLINGS, NOW AVAILABLE TO THE FIRE PROTECTION INDUSTRY.

GUSTIN-BACON MANUFACTURING CO.

1412 W. 12th ST. KANSAS CITY, MO.

Fast Acting Fire Watchman



on duty 24 hours a day...

AT EACH FIRE HAZARD POINT

Let C-O-TWO safeguard your property from fire, even if you have a night watchman on duty. With a C-O-TWO Combination Smoke Detecting and Fire Extinguishing System you have an automatic, round-the-clock fire watchman that simultaneously guards each fire hazard point. The first trace of smoke in a protected area is drawn through pipes to a smoke detector. Immediately an alarm sounds ... then fast, clean carbon dioxide gas fully floods the stricken area ... the fire is out before it has a chance to spread and cause extensive damage.

Actual fire tests made by the Underwriters' Laboratories, Inc. show that fire detection with this type of smoke detecting equipment is much quicker than other methods ... because usually there is smoke or smoldering before flames break out.

There is no water damage, no lingering odors with carbon dioxide ... only damage is that actually caused by the fire itself. Carbon dioxide is clean, dry, non-conducting and non-damaging ... harmless to finishes, materials and equipment. The fire is out in seconds, with hardly any interruption or commotion.

Remember fire doesn't wait ... let an expert C-O-TWO Fire Protection Engineer advise you on your fire protection needs now, before fire strikes. Write today for complete free information!

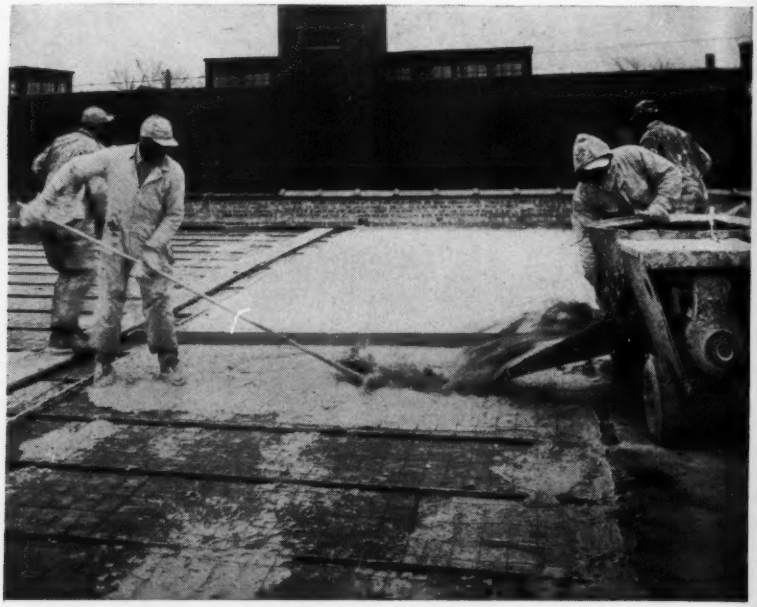
C-O-TWO

C-O-TWO FIRE EQUIPMENT COMPANY

NEWARK 1 • NEW JERSEY

Affiliated with Pyrene Manufacturing Company

SALES AND SERVICE IN THE PRINCIPAL CITIES OF UNITED STATES AND CANADA



NONCOMBUSTIBLE

OWENS-CORNING FIBERGLAS INSULATING FORM BOARD

for Fire-Safe Gypsum and Concrete Roofs

Made of ageless fibers of glass, Fiberglas* Form Board will not burn or support combustion.

Weighing but .87 lb. per square foot, this board imposes negligible dead weight on the structure. It has excellent thermal and noise reduction characteristics. It can be spray-painted without alteration of its properties. Applied only by authorized contractors, Fiberglas Form Board is a practical roof material of enduring fire safety.

OWENS-CORNING FIBERGLAS CORPORATION

Dept. 117-J Toledo 1, Ohio

FIBERGLAS IS IN YOUR LIFE...FOR GOOD!

*Fiberglas is the trademark (Reg. U. S. Pat. Off.) of Owens-Corning Fiberglas Corporation for a variety of products made of or with glass fibers.

You know how to operate this extinguisher ... JUST BY LOOKING AT IT!

2½ and 4 lb. Models. Famous "one hand" instant operation.

Simple, ***obvious*** operation makes the Randolph really panic-proof—gets it into action ***before*** the fire spreads —kills fire instantly with a snowy cloud of CO_2! No valves to turn, no nozzles to adjust; just point and press your thumb! Randolph CO_2 is non-damaging, evaporates without a trace. It's non-toxic, won't conduct electricity, deteriorate or freeze.

25 lb. Model. Mobile defense against severe, large-area fires. One man operation.

UNDERWRITERS' APPROVED — COMPLETE LINE OF EXTINGUISHERS AND SYSTEMS. Learn how Randolph gives your plant better preventative fire protection! Write or wire:

RANDOLPH Laboratories, Inc.,
24 E. Kinzie St., Chicago 11, Ill.

15 lb. Model. Self-balanced extra range and capacity.

10 lb. Model. Long-range hose and nozzle, easily portable.

Randolph
SIMPLIFIED FIRE EQUIPMENT

WHAT do you "FILE and FORGET"

Important savings may be effected by the proper classification of business documents.

The authoritative National Fire Protection Association (NFPA) lists four separate types of documents: Class 1 (VITAL), Class 2 (IMPORTANT), Class 3 (USEFUL), and Class 4 (NON-ESSENTIAL).

It's not necessary to store non-essential papers in a vault, safe, insulated container or insulated file—constructed for maximum protection under all conditions. Conversely, it is false and dangerous economy to house vital papers in a safe container designed only for limited protection.

Good management dictates an approach to the question of safe-equipment that offers *the soundest record-protection at the lowest cost.*

Your local safe-equipment representative will be more than happy to advise you on document classification, and on the safety-ratings of your present equipment. He's a good man to know. Consult him today.

SAFE MANUFACTURERS NATIONAL ASSOCIATION, Inc. 366 MADISON AVE., NEW YORK 17, N. Y.

RELIABLE

AUTOMATIC SPRINKLER DEVICES

PROTECTING LIFE AND PROPERTY FOR OVER 25 YEARS

Reliable Automatic Sprinkler Devices have an excellent field record . . . superb in design and construction . . . are universally approved by all Fire Insurance and Governmental Authorities . . . and effect maximum reductions in fire insurance premiums.

They comprise a complete line including Automatic and Open Sprinklers, Alarm Valves, Dry Pipe Valves, Accelerators, Circuit Closers, Water Motors and all other accessories required in Sprinkler Systems.

Reliable Systems are protecting thousands of properties throughout the United States, Canada and foreign countries.

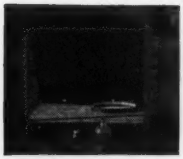
FURTHER INFORMATION UPON REQUEST

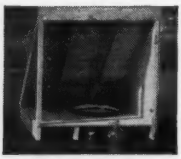
Manufactured and Distributed by

The Reliable Automatic Sprinkler Co. Inc.

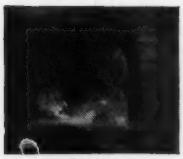
BRONX STREET — MOUNT VERNON, N. Y.

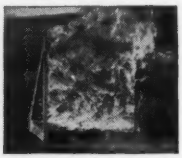
TESTS CONFIRM...



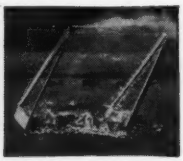


Test structures built of Koppers fire-retardant wood (left) and untreated wood (right) ready for the fire test. Five quarts of kerosene, placed in pans, furnishes fuel for each blaze.





Both structures are quickly enveloped in flame. Treated structure resists fire, but untreated one encourages it, contributes fuel to the fire.



After twenty-two minutes the untreated structure, still burning, is collapsing. Note that in the treated structure, the fire stopped when the fuel burned out.

KOPPERS

KOPPERS PRESSURE-TREATED WOOD

KOPPERS COMPANY, INC.
PITTSBURGH 19, PA.

fire retardance of KOPPERS CZC(FR)

Koppers fire-retardant wood is suitable for use as flooring, roofing, sheathing and structural members of industrial buildings, garages, airplane hangars, munitions plants, docks and warehouse buildings, railroad engine houses, and other similar structures. Koppers CZC(FR) treatment has a valuable plus advantage, for it also fortifies the wood against decay and termite attack. Color and paintability are not harmed by the odorless CZC(FR) treatment.

Investigate the possibilities of this new Koppers development. Send for your copy of the booklet, "Koppers Fire-Retardant Wood." Filled with interesting, helpful information.

Right · The treated structure was charred . . . but retained its integrity and strength, as the 800 pound load shows.

Left · Continued burning reduced the untreated structure to ashes.

In The Background Till Fire Strikes

Fits in smoothly with the most modern interiors. Barely visible, but ready at a second's warning to spring into action. Viking Flush Type Sprinkler Heads offer great *dependability*, plus true functional design. Get all details today from the *Viking* representative in your neighborhood.

THE VIKING FLUSH TYPE SPRINKLER HEAD

VIKING CORPORATION REPRESENTATIVES

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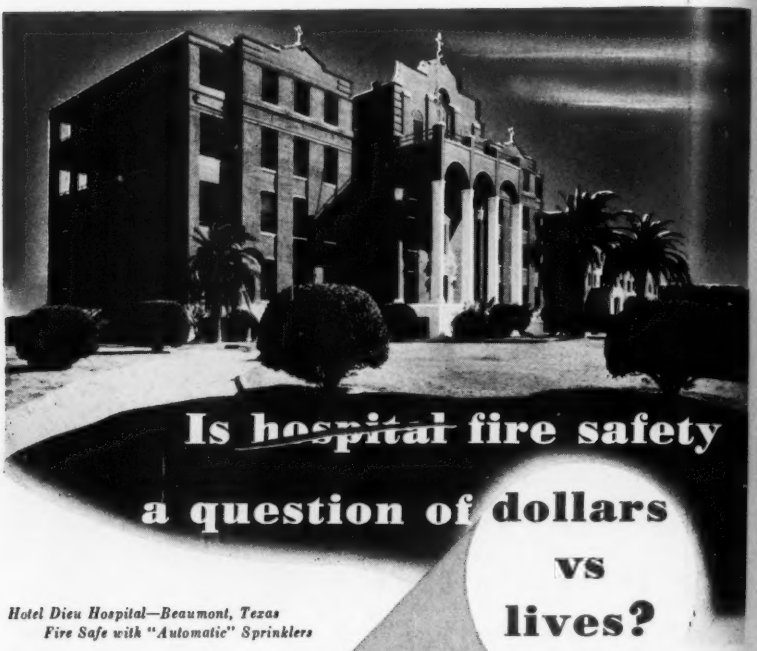

Is ~~hospital~~ fire safety a question of dollars vs lives?

Hotel Dieu Hospital—Beaumont, Texas
Fire Safe with "Automatic" Sprinklers

If fire protection measures are warranted in commercial and industrial structures where dollars are at stake, how much more necessary is every possible safeguard in buildings where helpless lives are constantly in jeopardy?

No building with flammable contents, regardless of construction, is *fireproof*. Only through the installation of "Automatic" Sprinklers can a structure be made *fire safe*. "Automatic" Sprinklers record of better than 99% fire extinguishing effectiveness is all conclusive.

You and every other executive with an appreciation of good business logic must not overlook the importance of absolute fire safety, for you can *save lives . . . save property and save money with* "Automatic" Sprinklers.

"AUTOMATIC" SPRINKLER CORPORATION OF AMERICA
YOUNGSTOWN 1, OHIO

"Automatic" Sprinkler
FIRST IN FIRE PROTECTION
DEVELOPMENT . ENGINEERING MANUFACTURE . INSTALLATION
OFFICES IN PRINCIPAL CITIES OF NORTH AND SOUTH AMERICA

GAMEWELL

Municipal Fire Alarm Systems

Until the Fire Department knows there is a fire — and the exact location — it can do nothing about it.

For the protection of the values at risk — human life, property, business and income — adequate fire alarm box distribution is a sound investment.

The Standard Municipal Box

GAMEWELL Three-Fold Type

INDUSTRIAL FIRE ALARM SYSTEMS

We also supply complete systems for industrials and institutions. Write for our catalog descriptive of the Vigilarm System of Automatic Fire Detection.

THE GAMEWELL COMPANY

Newton Upper Falls 64 - Massachusetts

A Continuing Contribution

Grinnell's specialization in the art and science of fighting fire automatically is a continuing contribution to the field of automatic fire protection.

During 100 years of invaluable experience, Grinnell has, through pioneering and research, developed a complete line of fire protection systems from which just the right type for practically any hazard can be readily selected.

Information on any of these systems is available for the asking from any of our offices in principal cities or Grinnell Company, Inc., Providence 1, R. I.

GRINNELL SYSTEMS

For Protection Against Fire